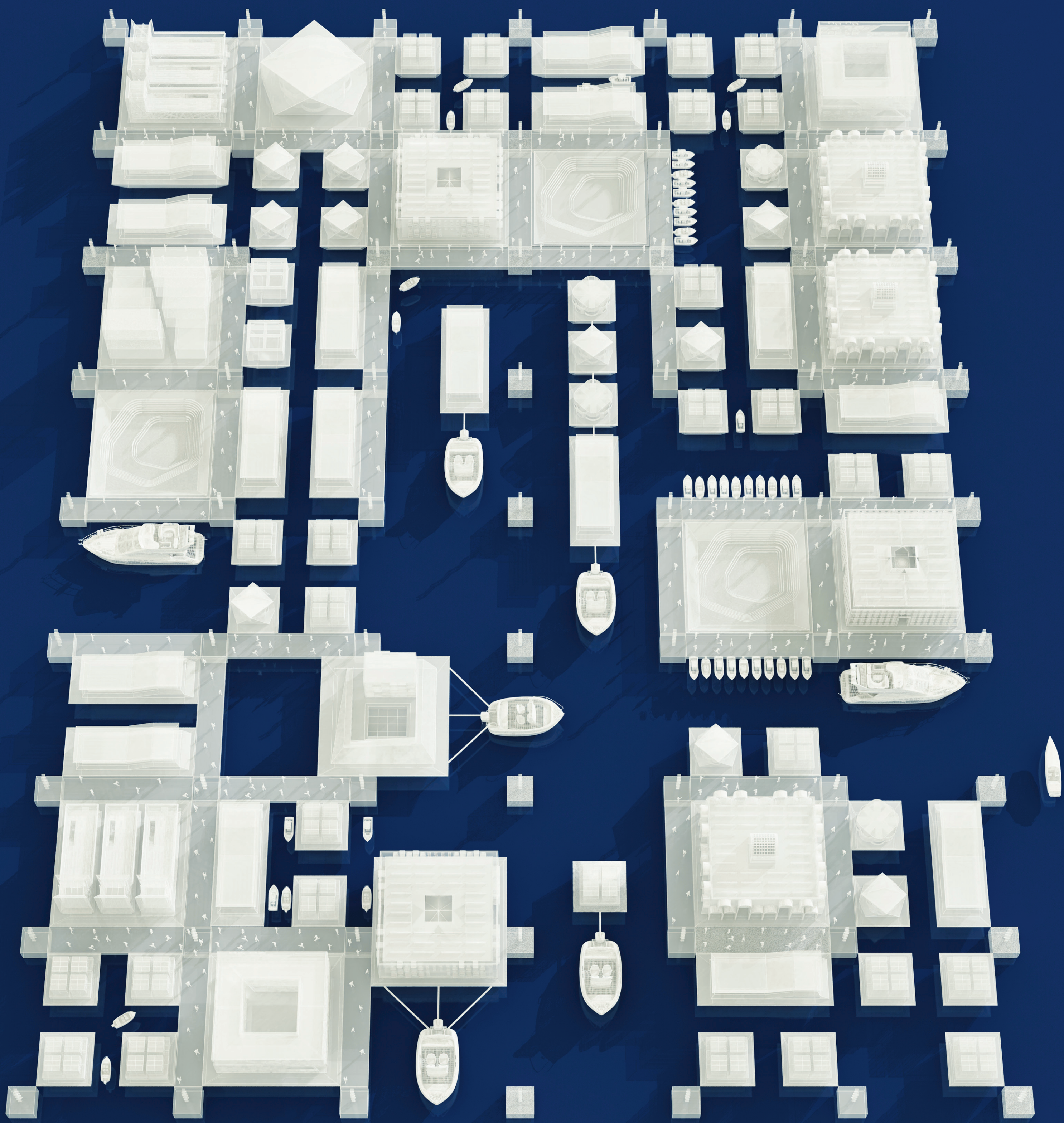
2014

A Transient Community for a Transient Lifestyle

sameh mohamed ibrahim
Virginia Commonwealth University, ibrahimsm@mymail.vcu.edu

A Transient Community for a Transient Lifestyle



Sameh Mohamed Ibrahim

Thesis Project | December 2014

Submitted to the Faculty of the Master of Fine Arts in Design of Virginia Commonwealth University in Qatar in Partial Fulfillment for the Degree, Master of Fine Arts in Design Studies

Signature Page

Approval certificate for Sameh Ibrahim for the thesis project entitled A Transient Community for a Transient Lifestyle. Submitted to the faculty of the Master of Fine Arts in Design of Virginia Commonwealth University in Qatar in partial fulfillment for the degree,   Master of Fine Arts in Design.

Sameh Ibrahim, B.Sc in Architectural Engineering, Mansoura University, Egypt, 2007.

Virginia Commonwealth University in Qatar, Doha Qatar, December 2014.

Dr, Thomas Modeen, Primary Advisor,
Assistant Professor
Master of Fine Arts in Design Studies

Peter Chomowicz, Secondary Advisor
Associate Dean for Research & Development

Roman Turczyn, Secondary Advisor
Director, Center for Research, Design & Entrepreneurship

Michael Wirtz, Reader, Head, Research and Library Technology, Assistant Professor Library and Master of Fine Arts in Design Studies

Dr, Thomas Modeen, Acting Director
Master of Fine Arts in Design Studies

Allyson Vanstone, Dean
Virginia Commonwealth University in Qatar

Dr. F. Douglas Boudinot, Dean
School of Graduate Studies Virginia Commonwealth University

Acknowledgments

Thanks, Mom, for your continuous encouragement and support throughout my learning journey.

I would like to express my deepest appreciation to my committee primary advisor Thomas Modeen, to whom I am indebted, for opening my mind to broader themes.

Furthermore, I would also like to thank my committee advisors, Peter Chomowicz, Roman Turczyn and Mike Wirtz for the advice and guidance.

I would also like to take this opportunity to thank VCU dean Allyson Vanstone, for the constant support to the MFA program.

Table of Contents

Acronyms and Abbreviations

OCED	Organization for Economic Cooperation and Development
UNICEF	United Nations International Children's Emergency Fund
UNEP	United Nations environment Programme
OCED	Organisation for Economic Co-operation and Development
EIA	U.S. Energy Information Administration
NDS	Qatar National Development strategy

Abstract

The project suggests an alternative means for living in Qatar. It proposes the development of a transient, floating community–a man-made, transitory archipelago of floating housing units located at the 'soon to be abandoned' docks a short distance from the Museum of Islamic Art and the Doha Corniche. The design, through a variety of bespoke dwelling options, can provide both more and less nomadic housing to accommodate a variety of different lifestyles and social units. Clustered around three permanent islands (containing a cultural/activity center, three adaptable 'work-unit' towers, and a park/commercial area), the design provides a wide set of adaptive layout patterns within which the mobile units can be arrayed. Directly plugged into the city, the community functions as a floating appendix to downtown Doha: an adaptable and flexible city-supplement that can expand or contract according to need, whether to aid in the accommodation of guests for various large-scale sporting or other events, or merely to provide an alternative locale for long or short stay visitors to Doha alike.

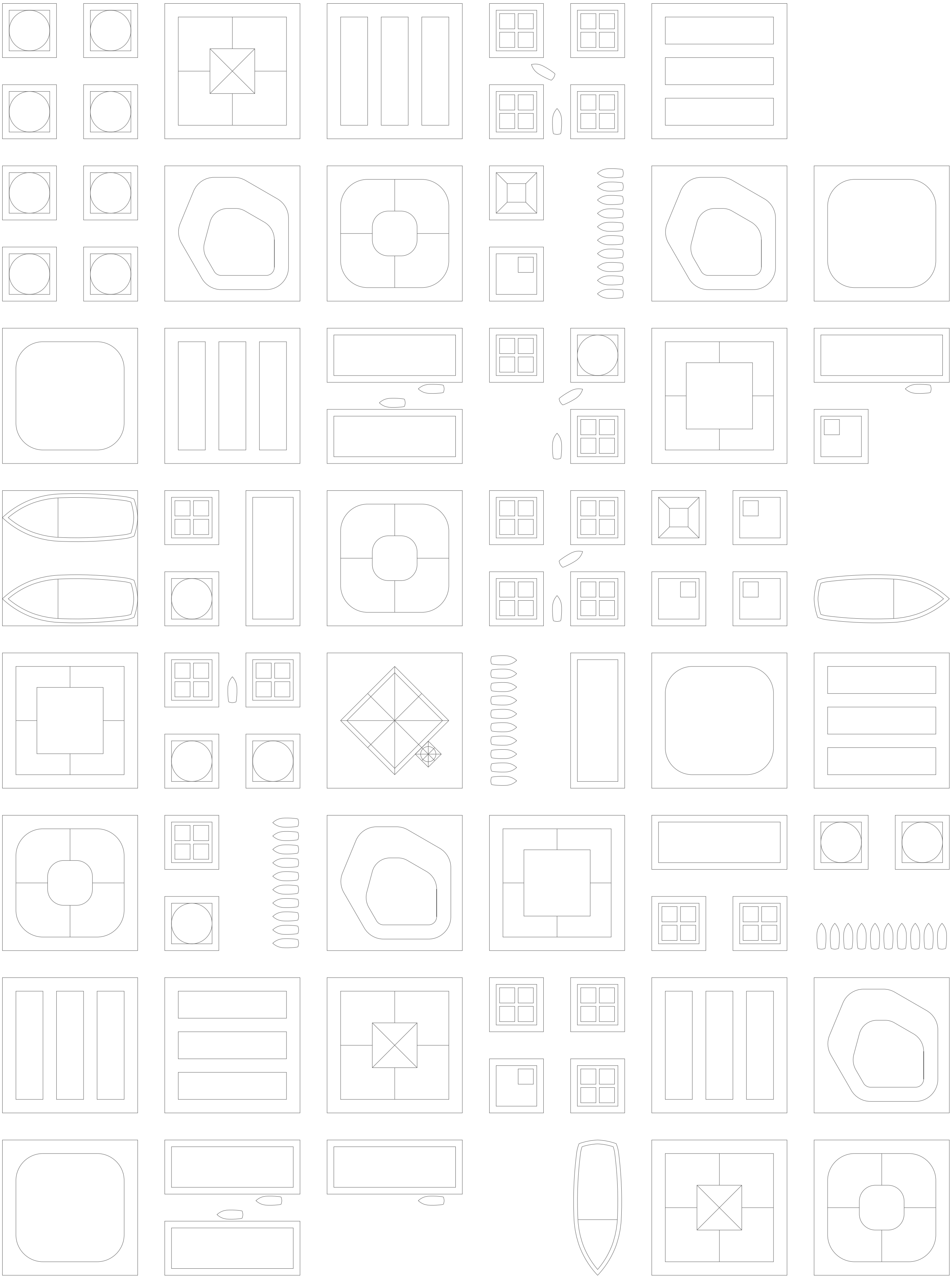


Figure 1: A blueprint plan for a transient floating community

Chapter 1: Situation

"Human beings are flexible creatures. We move about at will, manipulate objects and operate in a wide range of environments. There was a time, not too long ago in evolutionary terms, when our existence was based on our capacity for movement and adaptability; indeed it is to this that we owe our survival as a species. Most cultures now lead a more or less sedentary life, but it could be that flexibility is once again becoming a priority in human development and that technological, social and economic changes are forcing, or at least encouraging, a new form of nomadic existence based on global markets, the world wide web and cheap, fast transportation."

Robert Kronenburg, 2007

1.1 Introduction

This thesis introduces a conceptual framework that can be realized with today's technologies to open the door for investigating the possibility of living on water as an alternative of living on land. Through discussing global urban problems such as rapid population, shortage of land and threats of climate change, the thesis highlights the importance of adapting more flexible strategies in city planning through exploring water as an adaptable medium to extend the urban fabric of cities.

A case study of Doha, the capital of Qatar, stands as an example of a coastal city facing unprecedented urban development. The project aims to take place in Doha and use the opportunity of Qatar's interest in promoting its global image in the coming 2022 World Cup event.

Various precedent examples are closely discussed in the thesis, justifying the design approach undertaken to develop the project, examining the capability of current technologies to build future urban development on water, and exploring other aspects such as techniques used to deal with hot weather in Qatar.

The idea of living on water has existed for a long time, and has been discussed in many ways and for different situations. This thesis introduces a realistic vision—a step-by-step approach that can be realized through a flexible framework applicable to diverse contexts with various configurations.

1.2 World Population

The world population is dramatically increasing. At the current time, the total world population exceeds seven billion.(1) In the last twenty years, the total urban population of the developing world has grown by an average of 3 million people per week.(2) In 2008, for the first time, the world's urban population exceeded the world's rural population.

As the urbanization level continues to rise rapidly, the total urban population of the developing world will increase from 2.3 billion in 2005 to 5.3 billion in 2050, and will reach 70% by the middle of the 21st century.(3)

TABLE 1.1.1: **URBANIZATION LEVEL PER REGION AND TIPPING POINT (URBAN VS. RURAL POPULATION)**

Region	Tipping point before 2010 (year)	2010 urban (%)	Tipping point after 2010 (year)	2050 urban (%)
World		50.6		70

Figure 2: : Table showing the percentage of urban vs. rural population of the world. Source: UN-Habitat, 2010.

1.3 The Urban World

In 2012, Unicef released an interactive data visualization map named "An Urban World." The map shows the urban population growth from 1950 to 2050, with countries depicted by their urban population. Circles are scaled in proportion to urban population size in millions, and shift from green to blue and from yellow to dark pink based on the percentage of the country's urban population compared to its rural population.(4)

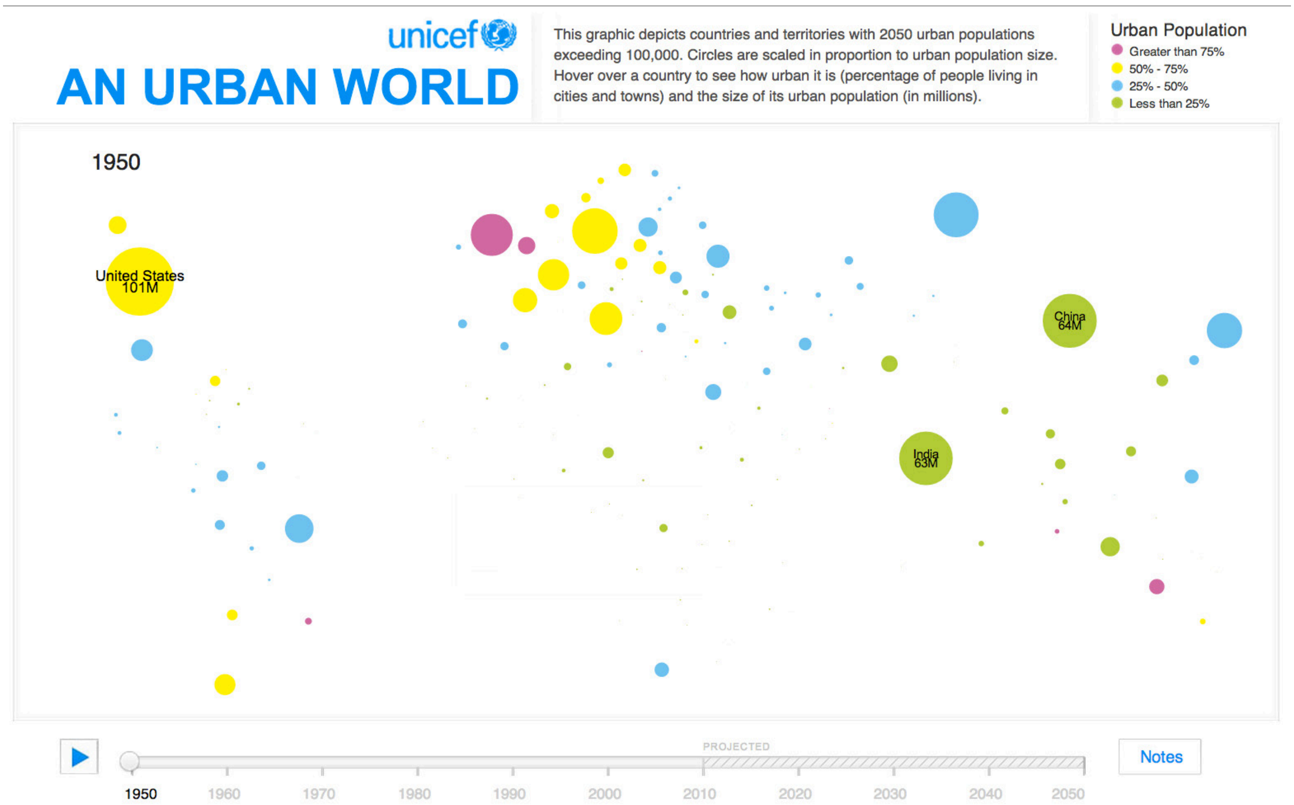


Figure 3: Data visualization map shows the urban world in 1950.

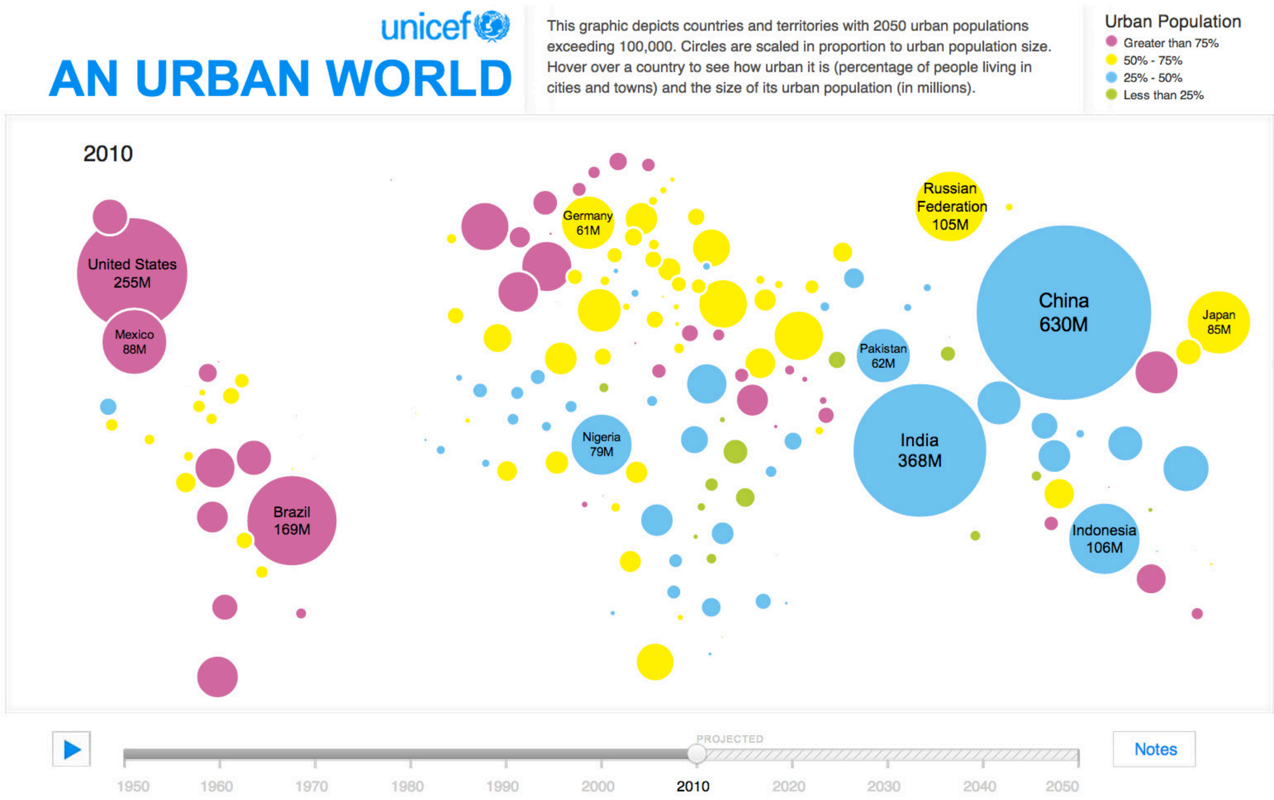


Figure 4: Data visualization map show the urban world in 2010.

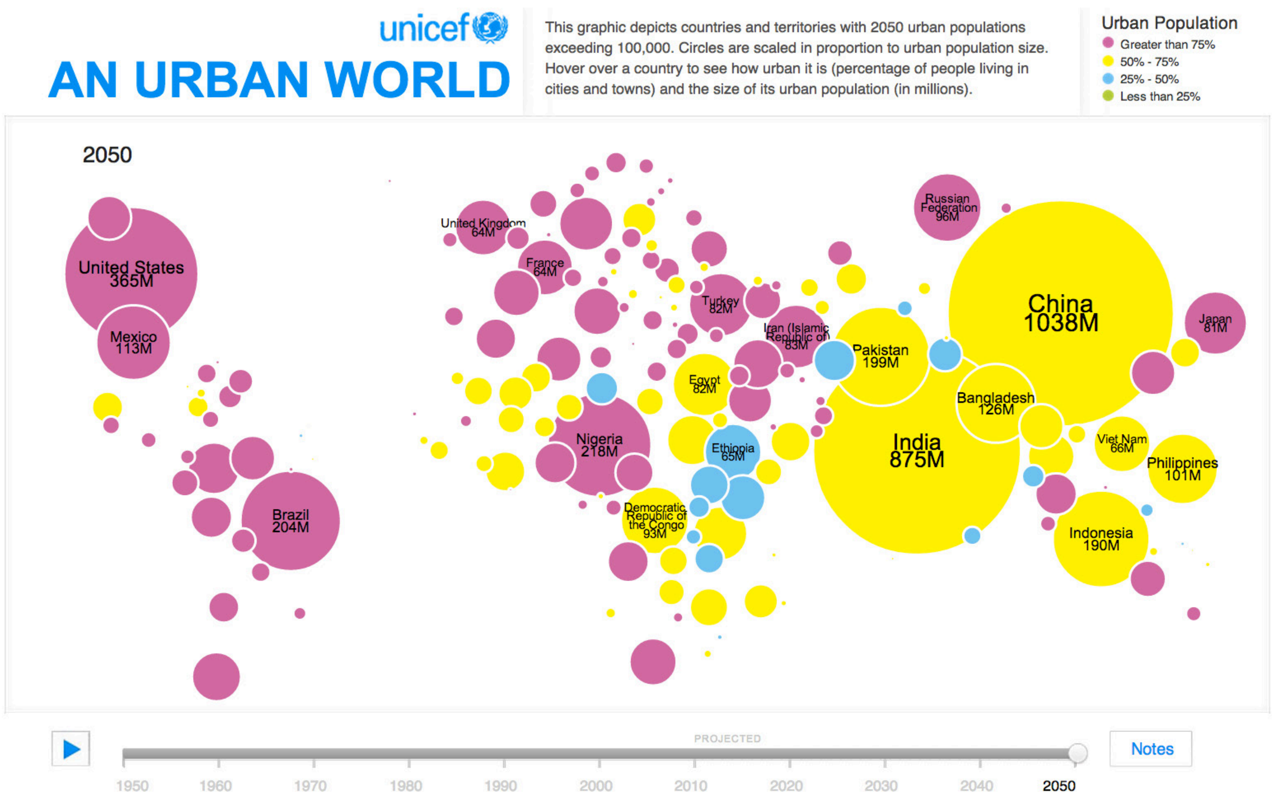


Figure 5: Data visualization map shows the urban world in 2050.

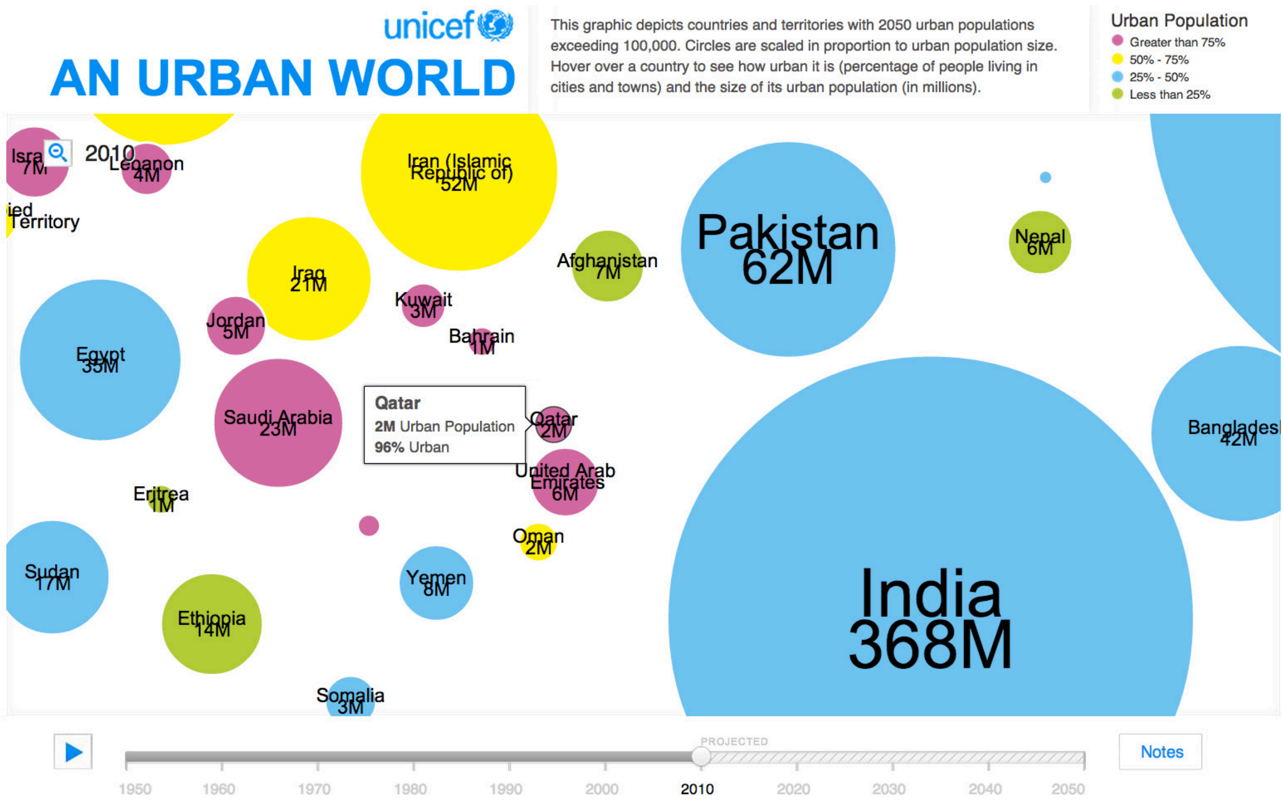


Figure 6: Data visualization map showing the Gulf region countries in 2010.

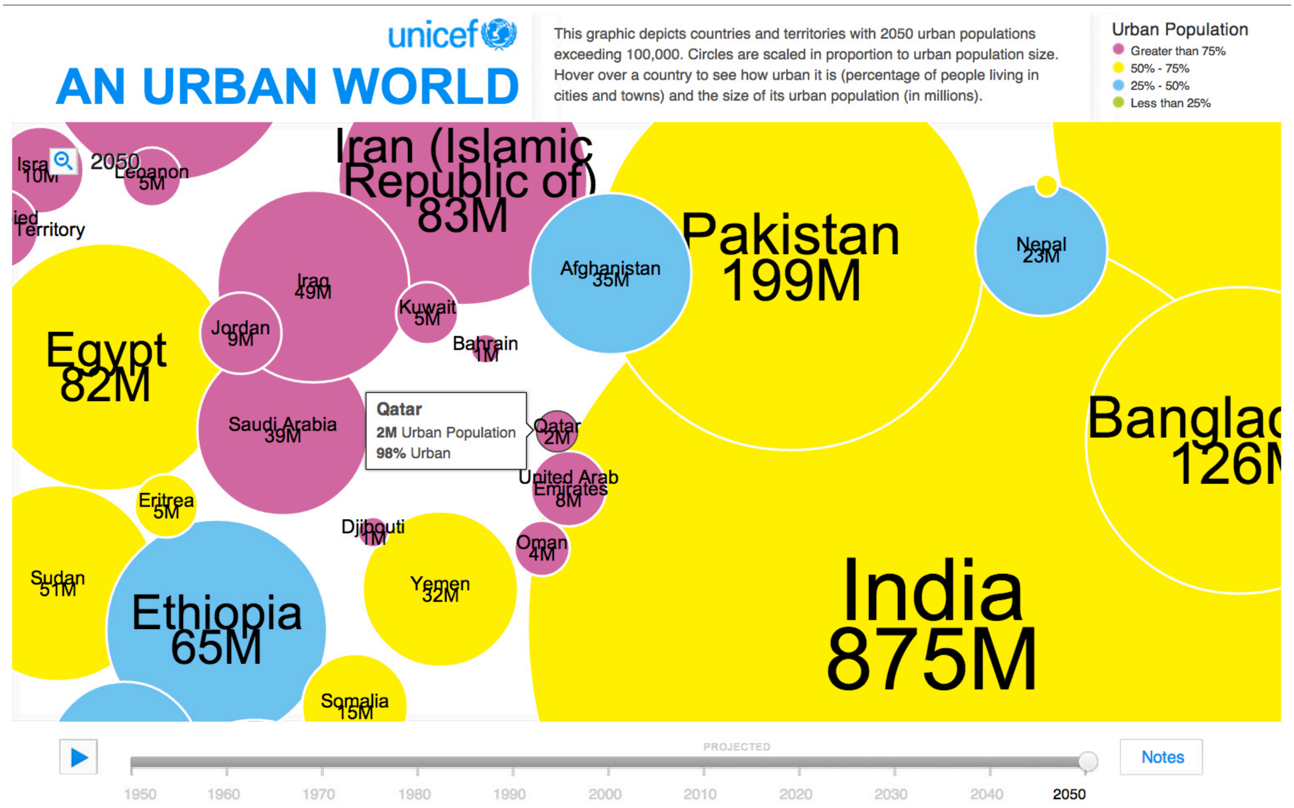


Figure 7: Data Visualization map showing the Gulf region countries in 2050.

By 2015, there will be 33 cities with a population of more than eight million.[(5)] As stated by Klein et al. (2003), 21 of these 33 megacities are located in coastal zones. With the exception of Tokyo, New York, Los Angeles, Osaka, Paris, and Moscow, all other cities are situated in developing countries.

Coastal developing cities are facing the challenges of climate change and future urban expansion.

Figure 8: An aerial view of New York City showing the urban expansion and the lack of territories

1.4 Climate Change

Many cities in the world today are coastal cities. According to UNEP,[6] location of coastal cities were historically built on sites originally chosen for trade and military advantages such as in the city of Shanghai and New York, etc. These coastal cities became the hubs of trading in the world, which increased their wealth. The economic growth resulted in urban development and population rise due to the continuous migration of labor to these cities. This trend continues in many coastal cities today, without regard to the environmental risks resulting from the climate changes.

According to studies by OECD, an international organization helping governments tackle the economic, social, and governance challenges of a globalized economy, many of the fastest growing coastal cities have little or no protection from future climatic changes.[7] Even in cities such as New York, Amsterdam, or London, where protection levels exist on an average levels, these cities will have to increase their future spending to combat future threats. While New York's ability to recover from Hurricane Sandy[8] was impressive, the city still faces great challenges, as do other coastal mega cities.

With the sea level steadily rising, coastal cities growing populations and their increasingly valuable infrastructure are under threat. A joint project between Building Future and the Institution of Civil Engineers in UK discussed the future of climate change within the urban context.[9] Their conclusion came to three long-term choices: retreat, defend, or attack.

• To retreat is to step back and build on safer ground, high from the future threat of sea levels. This means to displace all coastal cities.

• To defend is to ensure protection from future sea levels, such as the Dutch method for protection such as building dams, dikes and floodgates.

• To attack is to advance and invest in building onto water, using floating structures for land reclamation.

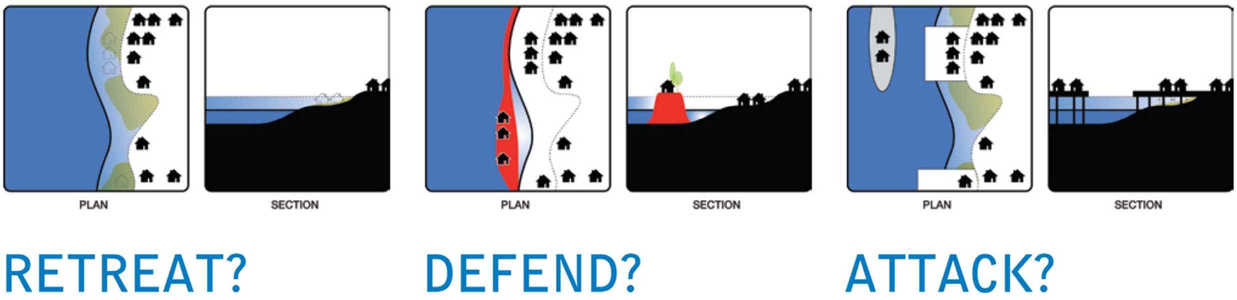


Figure 9: : A diagram showing three different strategies to deal with rising sea levels within the urban context.

In 2009, the President of the Maldives declared that he was being forced by rising sea levels to buy land in Sri Lanka to provide enough space for 350,000 people. [10]

Figure 10: An aerial shot of Male Island, the capital of Maldives

1.5 Urban Expansion

With the rapid population growth all over the world, cities are always in the process of urban expansion. Richard Florida[11] describes how urban structures grow in his paper, "The Rise of Mega-Regions." He states that there are two rules:
Rule 1: They continue growing; they practically never reduce in size.
Rule 2: Multiple structures often merge into mega regions.

Example: The economic transformation of China, for example, is by no means evenly spread across its vast territory but rather focused in dynamic coastal mega regions. This phenomenon has produced the most massive urban migration in history.

The urban population growth for cities shows that in order to accommodate their population, cities have to expand horizontally by using the unbuildable terrain surrounding the city, or vertically by increasing the density of the built areas, or both.

Increasing Density:
Urban density is usually expressed in population per square kilometer or square mile. Increasing the number of inhabitants in a certain space is a limited solution for rapid population growth. Mega- coastal cities such as Tokyo run out of surrounding land as the density of Japan reaches 4400 (p/km2). This affects the quality of life for inhabitants.[12]

'Quality of life'[13] refers to the general wellbeing of individuals and societies. It includes the built envi- ron- ment, recreation, leisure time, and sense of social belonging. Increasing the number of inhabitants in the same space will decrease the quality of life for each inhabitant. The denser the city, the more facilities and activities need to be provided within a limited space. This is a great challenge for cities that almost came to a dead-end by achieving the maximum density.

On the other hand, expanding horizontally places the infrastructure under pressure, reaching a limit where it is difficult to maintain. Operating infrastructure over vast spaces would affect the cost and quality of the services provided.

The bellow pictures show aerial shots of sheikh Zayed road in Dubai city in 1990 and 2008 respectively. The pictures show the vertical and horizontal expansion of the urban development.


Figure 11: Sheikh Zayed road, Dubai 1990.


Figure 12: Sheikh Zayed road, Dubai 2008.

1.6 Expatriates and the Dynamic population

We are nomads. As Robert Kronenburg states in his book, *Flexible: Architecture that Responds to Change* (2007), "Human beings are flexible creatures. We move about at will, manipulate objects and operate in a wide range of environments. There was a time, not too long ago in evolutionary terms, when our existence was based on our capacity for movement and adaptability."[14]

Populations in large and mega-region cities are dynamic. Cities work as nodes to attract expatriates who represent neo-nomads roaming between cities looking for new opportunities. The world's expatriate population has increased dramatically from 1960 until now.
In 1960, the number of expatriates across the globe numbered 73 million people. In 2013, it reached 230 million people. If the population of expatriates were considered a country, it would be the fifth largest in the world. Expatriates now form 3.1% of the global population of the world. One expatriate moves abroad every 44 seconds.[15] Neo-nomads have incorporated the habits of adapting swiftly to the cities they inhabit. They extend, cling, and detach in a way that influences the urban fabric of cities.

The top five countries with highest share of expatriates in total population are:[16] Qatar (86.5%), UAE (70%), Kuwait (68.8%), Jordan (45.9%) and Singapore (40.7%). If these statistics of the rapid population of expatriates reflect one thing, it is that cities are dealing with more dynamic changes than ever before. These changes are economical, technological, cultural and social. Cities should respond to changes, but the speed at which they occur demands a high level of flexibility in the built environments. This requires a new framework of urban structure—a structure that can easily and interactively respond to change.

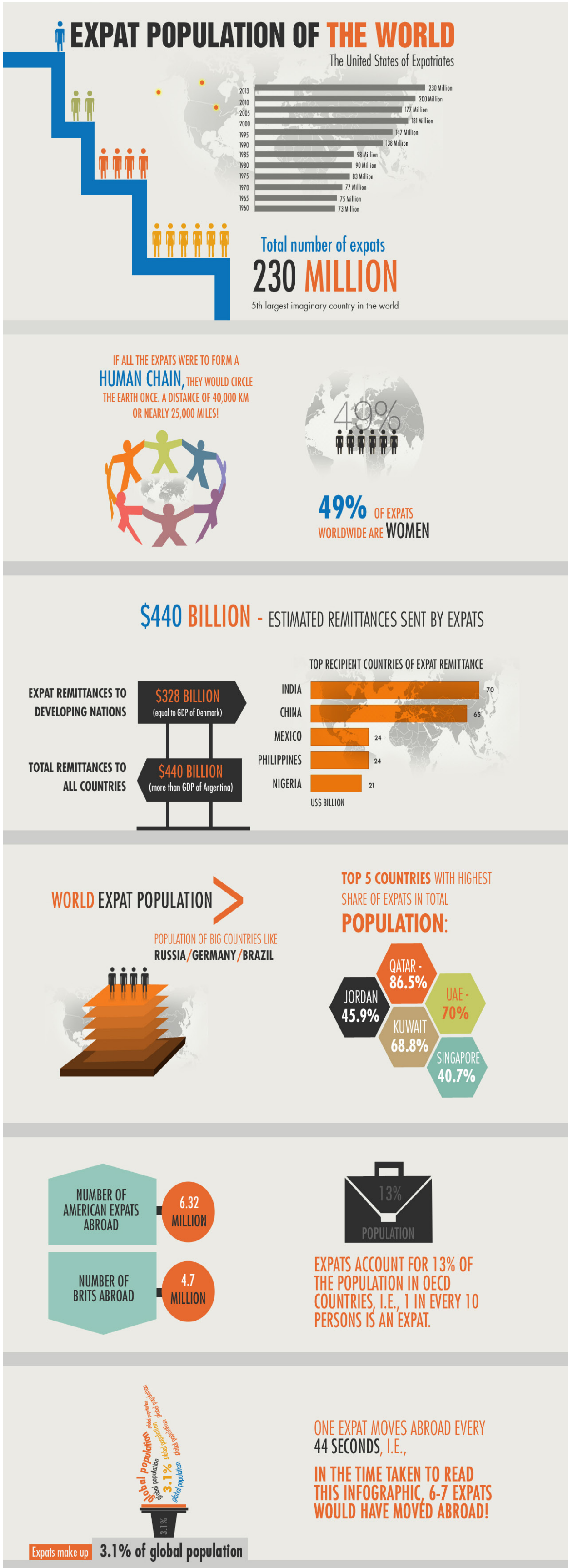


Figure 13: An info graph by feedbacq collected from various sources.

Chapter 2: Qatar

2.1 Qatar and Future Urban Challenges

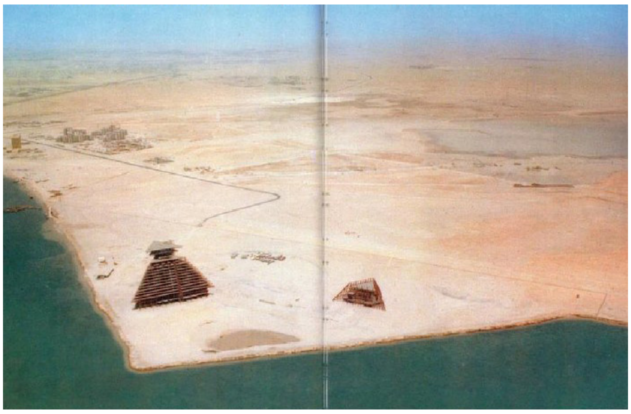


Figure 14: Photo courtesy of Sheraton Doha 1980, West Bay

Figure 15: Photo by Fadi Al-Assaad/Reuters 2013 showing development of Doha, West Bay.

Currently, Qatar has one of the fastest-growing economies in the world as the largest LNG (Liquified Natural Gas) supplier according to EIA. (17) Pollution is reduced by more than half by burning natural gas as opposed to oil. For this reason, the demand for cleaner fuel throughout the world is expected to increase by 50% over the next 25 years. (18) This factor plays a key role in providing the country with steady economic growth.

Due to its vast resources and rising global demand for clean fuel, the country is booming in every aspect. The Qatar National Vision 2030 is set to transform the country into an international node of tourism in the Middle East and Asia. Additionally, the promotion of culture by the burgeoning Qatar Museums Authority and heritage sector will likely transform Qatar into a prestigious venue for international events.

The country has already been under the spotlight for hosting international and regional events such as the Doha Tribeca Film Festival, World Petroleum Congress, Asian Games 2006, Arab Games 2011, International Handball Federation (IHF) World Cup 2015, and later the World Cup 2022.

As Qatar was awarded the bid to host the World Cup in 2022, the country is experiencing one of the fastest developments in its history, especially in its capital city, Doha. A number of mega infrastructure projects are taking place to prepare the country for coming global events such as Lusail City and Qatar Rail and Metro, in addition to FIFA requirements to provide approximately 60,000 hotel rooms (19) in time for the global tournament.

As a result, Qatar must expeditiously respond to the problem of accelerating urban development.

Although the established steady economic growth should continuously provide the necessary funding to complete ongoing projects, there is always the risk that the scenario of Dubai, which suffered a severe

Figure 16: A panoramic view of Doha waterfront in 2005.

Figure 17: A panoramic view of Doha waterfront in 2007.

Figure 18: A panoramic view of Doha waterfront in 2009.

Figure 19: A panoramic view of Doha waterfront in 2011.

economic downturn in 2009, might repeat itself in Doha.

This rapid development has had a serious negative impact on the urban image of the city in terms of sustainable urban planning. The pressure to build everything at once and in a short period of time has unfortunately resulted in the construction of useless structures, traffic congestion, and a rise in pollution levels. These problems are already affecting Doha eight years in advance of the World Cup.

2.2 Infrastructure

Adding on to or developing the established urban infrastructure pattern will increase the pressure on already existing facilities and roads. While expanding and developing the urban pattern, it is essential to implement high-quality services. More importantly, there is a direct relationship between maintaining the quality of the infrastructure services and the number of inhabitants demanding these services.

In addition to that, the infrastructure and housing projects will take years to complete. Current figures for Qatar show that the population will continue to dramatically increase, [20] putting the existing infrastructure under enormous stress. This will in turn reduce overall productivity if people are forced to spend more time in traffic jams and crowded areas.

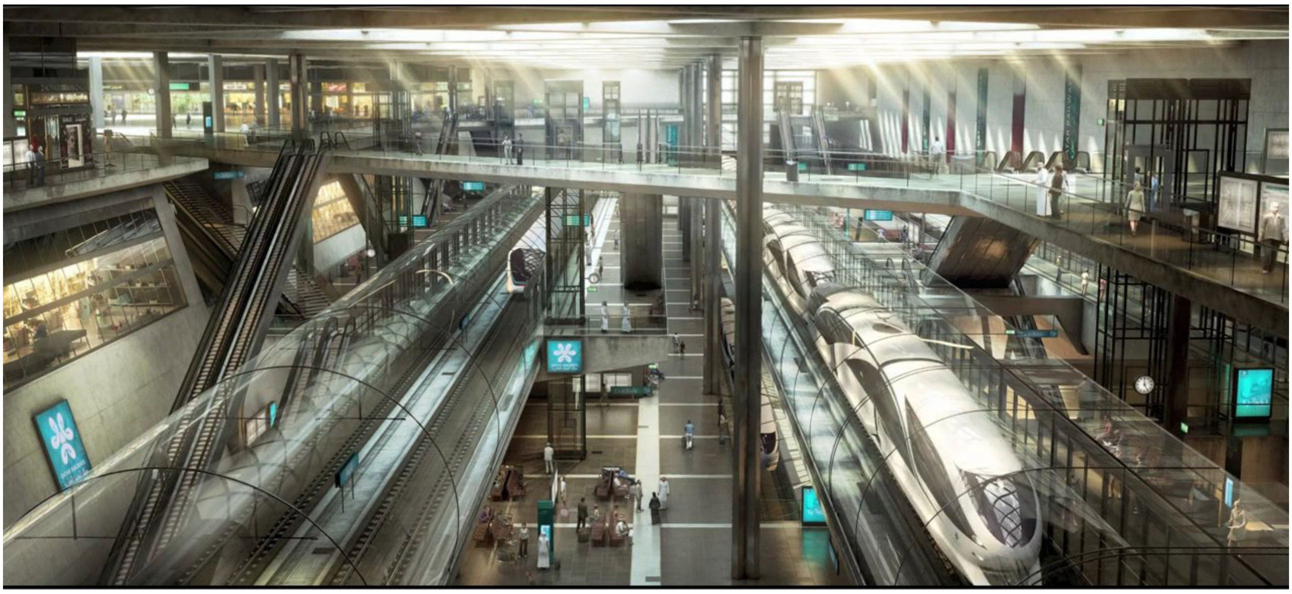


Figure 20: A render shot showing a metro station in Qatar, an integral part of the Qatar Rail development program.

2.3 Tourism

According to Qatar Tourism Authority statistics report in 2013, the hotel sector is growing at an incredible rate. Currently, there are 124 hotels under construction to provide a total number of 21,294 rooms.[21] However, it is worth mentioning that most tourists come to Qatar for business trips or to attend locally hosted international events and conferences.[22] The current tourism sector accounts for less than 1 percent of the national GDP. The country is expected to spend 20 billion USD on developing its tourism infrastructure to expand the tourism sector by 20% in the next five years.[23] This means there should be an economic study between the current investment in the tourism sector and the expected outcome from these investments. In other words, Qatar should create a situation, other than the World Cup 2022 event, where outcomes are expected to continuously increase.

Figure 21: A panoramic view of Doha waterfront in 2011.

2.4 Tourism and Global Sport events

Hosting international sport events such as the Olympic Games or World Cup is a glory for any city due to the prestige affiliated with such events. Cities prepare for events by building sport facilities and updating the infrastructure and hospitality sector. Once the events end, however, the question arises of what to do next with all the facilities being built to accommodate a large number of visitors in a compressed time.

Two case studies represented by two cities, Athens and Barcelona, show unsuccessful and successful strategies respectively.

2.4.1 Case Study: Athens

In 2004, Athens hosted the summer Olympic Games, pouring an immense amount of money into buildings, venues, and facilities for the games. Ten years later, the Olympic City Project[24]—an ongoing documentary photography project chronicling what happens after a city hosts the Olympic Games—shows a chain-linked fence around many of the venues now in disuse. Due to this lack of vision in wasting billions of dollars on the Games, Greece was stricken by economic depression and public anger.[25] As Athens showed, planning after hosting global events is as important as hosting the event itself. A flexible strategy for city planning is needed.

Figure 22:The Olympic beach volleyball lies abandoned in southern Athens. *Source*: AP Photo.

2.4.2 Case Study: Barcelona

Hosting sport events is a catalyst for infrastructure, transportation, and other facilities improvements. Barcelona benefitted greatly from hosting sport events that revived the city. The 1992 Olympics turned the city from an industrial hub to a popular tourist destination, as the city improved its infrastructure and opened the waterfront for public use. Nowadays, it is a huge tourist attraction with a thriving waterfront district.

After the successful summer Olympic Games in 1992, Barcelona became the fifth most popular European destination for tourists and the fourth busiest cruise-ship port in the world by passenger, tripling the number of tourists in the last 20 years.[26]

Figure 23: Photo by Bob Martin of British diver Performing at the Barcelona Olympic Games in 1992.

Figure 24: Diver perform at the FINA Swimming World Championships in Barcelona 2013.

Barcelona used the Olympics as a catalyst to reconnect the city to the waterfront, which turned into a great success for the city from many fronts.

Figure 25: Satellite Image showing Barcelona city waterfront. *Source* : Google earth.

2.5 Population

The population of Qatar is expected to increase dramatically over the coming years in order to complete the mega development projects linked to hosting the 2022 FIFA World Cup. Over 200,000 expatriates and workers arrived in the country in 2013,[27] increasing the population from 1.83 million in 2012 to 2.18 million in September 2014.[28] The national development report strategy by NDS claimed that Qatar's population will rise slightly between 2011 and 2016 to reach 1.9 million by 2016;[29] this means that the population has increased two years before the target year. As the construction worker population expands to enable Qatar's commitment to ongoing urban projects, more housing units and facilities such as schools and hospitals will be needed. This will eventually lead to the need for more workers and professionals to build and operate these facilities. Consequently, the population is increasing much faster than predicted.

The urban population of Qatar is over 2 million. 99% of the entire population lives in cities, according to the World Bank,[30] with a population density of 187 people per km^2.[31] Qatari nationals comprise 300,000 of the total population,[32] meaning that Qataris make up less than 20% of the population as a whole.

Qatar's population is expected to witness fluctuations before and after the World Cup. By the time of completion of Qatar's mega projects and FIFA requirements , the number of laborers and expatriates working in construction projects may decrease. This raises the question of what will happen to the housing sector, especially the one dedicated for expatriates and laborers in the long term. This thesis project will focus on the lives of white-collar expatriates by attempting to address the rapidly fluctuating population without increasing pressure on the existing infrastructure.

One of the primary reasons for expatriates to move to Qatar is prosperity, as Qatar offers good opportunities for those who are looking for greater financial rewards and better working conditions than those found at home. This trend continues due to Qatar's strong economy. However, 30% of expatriates who live in Qatar would like to leave the country, according to the HSBC Expatriate Survey published in 2012.[33] The study shows that expatriates living in Qatar and the Gulf countries retain a stronger affiliation with their home country than expatriates in general, who tend to plan to set a limited period of their life aside to take advantage of the healthy economy of these nations before returning to their home country. In Qatar, the main reason given by expatriates for leaving is the need for change: 61% of expatriates who want to leave Qatar are not looking for better opportunities in employment, but for more variety in their social lives.[34] Respectively, this means that Qatar needs to turn the country into a hotspot of the Middle East for expatriates who are looking for higher salaries/investments and interactive lifestyles to match the country vision for developing its tourism sector. This would also have the economical benefit of encouraging expatriates into making long-term investments inside the country.

2.6 Traffic

Although the population slightly exceeded 2 million, the total number of registered vehicles in Qatar exceeded 1 million, as claimed by the Director of Traffic Department, Mohamed Saad al Kharji.(35) Put in another way, an excessive use of cars on the road is the main cause of the daily traffic jams. With the rapidly increasing population, however, there is no sign of relief.

It is an important issue that the World Cup football matches in Qatar 2022 will take place in 12 stadiums over seven cities. According to the Qatar bid, ten of the twelve stadiums will be located within a 25-30 km radius of Doha.(36) This will present an operational and logistical challenge with the annual growth in the number of cars on the roads.

While many view the current urban and infrastructure plans as a sign of economic prosperity in the interest of Qatar's citizens, an opposing view also sees this impact as a threat to quality of life. The environmental impact is already a growing concern, and the way such problems may affect social wellbeing are being reviewed in Qatar National Vision 2030. As the city accommodates its growth, the automobile-oriented lifestyle may lead to a decline in quality of life—for example, through increased commuter times from traffic.

Figure 26: A picture showing traffic jam in West Bay, Doha. *Source:* Pihc. 2013

2.7 Pollution

Qatar is one of the most polluted cities in the world according to United Nations Human Settlements Programme (UN-Habitat).[37] The growing construction sites and enormous use of cars are key contributors. The country has one of the highest carbon emissions in the world, which is a direct cause for rising sea levels and global warming. There is no sign that Qatar will slow down its ambitious plan for building the country, as the commitment needed to fulfill the World Cup requirements in 2022 and Qatar National Vision will keep the country booming in every aspect. As a conclusion, Qatar needs to contribute toward finding solutions to decrease pollution levels; investments in new alternatives to prepare for future climate challenges is therefore worthwhile and a must.

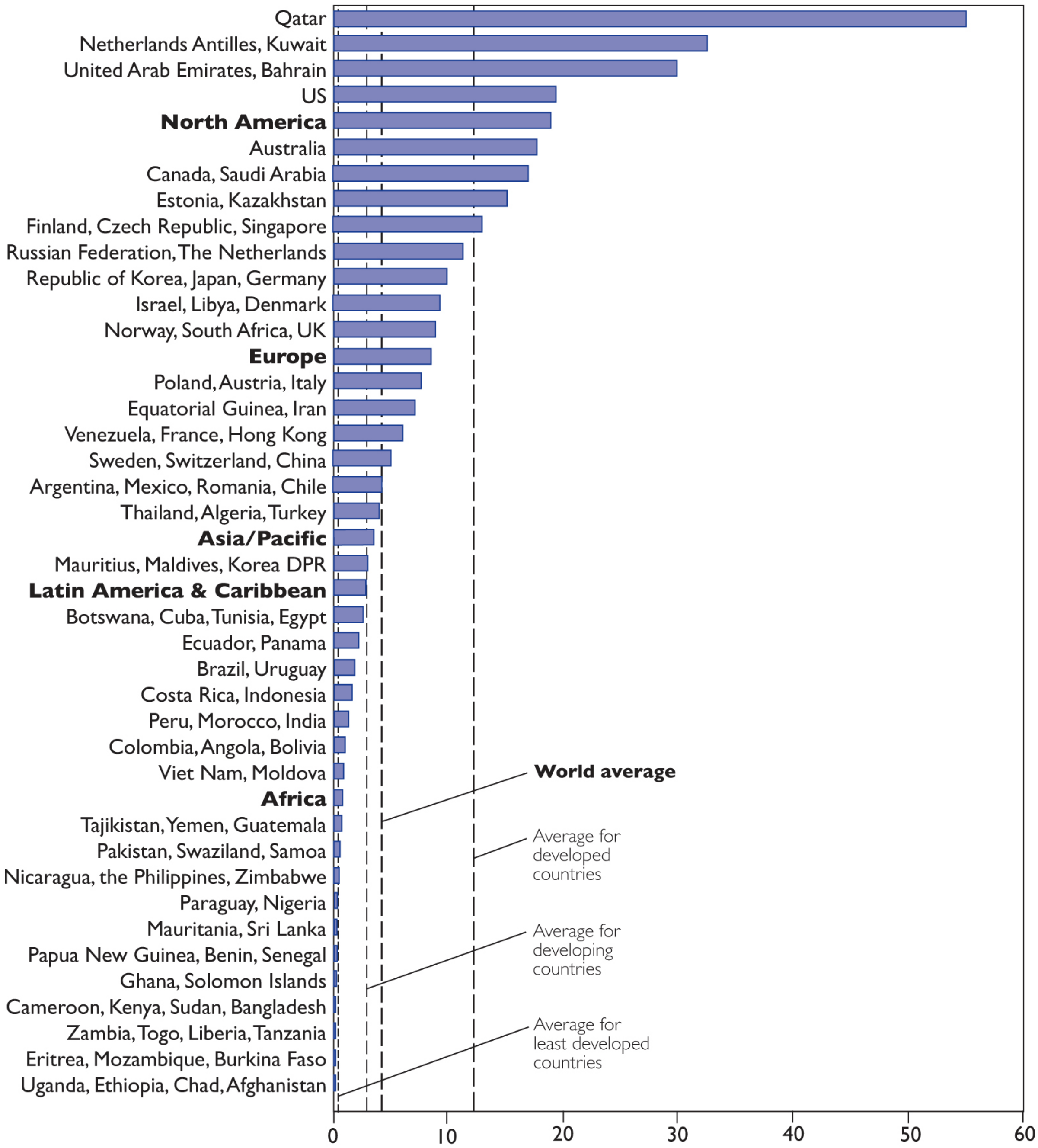


Figure 27: CO2 emission (metric tonnes per capita) 2007. *Source:* UN

2.8 Building Life Span

Notably, as an observer expatriate living in Doha, I realized that the life of a building is relatively short compared to the planned building design life.

Although the lifespan of building in Qatar averages 75 years, in accordance with Qatar building code, the country is planning to increase the average lifespan to 100 years through implementing the highest standards in the field of construction. [38] However due to the speed of urban development taking place, whole districts within Doha are being demolished. One example is the new Msheireb district, which is considered to represent the symbolic heart of Doha. Other buildings have been demolished to make way for new infrastructure and have become part of an ongoing process of constant modifications to reshape the city. This unsustainable practice may reveal negative impacts over the long term in terms of function, aesthetics and economics.

The 'top-down plan' is a term used to explain the process of the government and the urban planning department when planning a city. For example, before the Asian Games in Doha 2006, the top-down plan requested speeding the process of building hotels to accommodate the number of tourists visiting the country. However, these plans were rushed and did not provide the enough parking spaces for high rise tower districts in general.

The top-down process should be integrated with a 'bottom-up plan,' or process in which different kinds of building take place based on a variety of needs from city inhabitants. Accordingly, a key premise of this study is to present alternative ways to integrate 'bottom-up' and 'top-down' models of sustainable urban planning to respond to the predominantly 'top-down' models currently in place.

A model of urban planning that holistically integrates and involves all sectors of society can improve the way construction is carried out so that the planning procedure happens from the bottom-up, rather than vice versa, which is the case at this current time.

Eventually, there will be no alternative other than to build more units to respond to the growing population. The provision of diverse housing alternatives within the time frame from now until the World Cup 2022 is essential in order to reduce pressure on the existing infrastructure and also provide a more appropriate response to the unavoidable demand for housing in the coming years.

The key premise of my proposal is to provide a flexible housing framework that can be applied in different situations with different scenarios. This framework will be developed specifically for coastal cities. One of its aims includes the capacity for adjustment in the future, so that it can provide an immediate response to the rising population. My design will utilize today's techniques as well as current and perhaps emerging technologies to apply them in the near future.

2.9 Doha and the waterfront

Thanks to oil and gas resources that boost urban development plans, many Gulf coastal cities have paid great attention to the revival and refurbishment of their waterfront. One example includes the construction of artificial islands along the coast line, characterized by their highly luxurious lifestyles, such as the Palm and the World Islands in Dubai, Durrat al Bahrain in Bahrain, and the Pearl in Qatar. This proposed project will focus on the city of Doha particularly.

Figure 28: Doha coastline comparison between 1956 and 2003, edited by the author.

2.10 Building on the waterfront

Even as rapid development challenges the quality of life and future of the country, Qatar is creating an innovative World Cup experience. Some of the World Cup stadiums will be reassembled and shipped to developing countries after the end of the event. People will have the opportunity to watch more than one match thanks to the short distances between stadiums and the new transportation infrastructure. These innovations will enhance Qatar's global image.

Like many other countries, Qatar understands the value of a visual identity. The predominant image of Qatar is the Doha waterfront, where heritage meets the future. The waterfront represents a collection of Qatar's achievements throughout its history and symbolizes the main gate to the city. It provides a path by Souq Wagif, Old Doha Districts, the airport, the seaport, towers and office spaces, gardens, embassies, and the Pearl. The waterfront is a unique opportunity for Qatar to propose a powerful visual image to the world through the World Cup. Al Corniche is a partially manmade waterfront, which includes the completion of Al Dafna district. There is no denying that Qatar is working to promote its global image in many ways. As more cities of the world construct rising skyscrapers to express their booming economic prosperity, Doha is following this global trend by building more skyscraper districts, such as Lusail and Al Dafna. Although this trend is difficult to slow, I argue that these rising skyscrapers fail to introduce a nation's values, identity, and culture. Rather, it is more important for Qatar to promote its image by introducing innovative urban solutions at the time of the World Cup.

The disadvantage of concentrating important activities on the waterfront is that these kinds of built up places require greater facilities and landscape to buffer concentrated urban development. In other words, the skyscraper district should be provided with enough parking spaces and landscape to make use of the beautiful skyline of Doha. My proposal aims to provide interaction between the waterfront and the city through expanding the urban fabric on water.

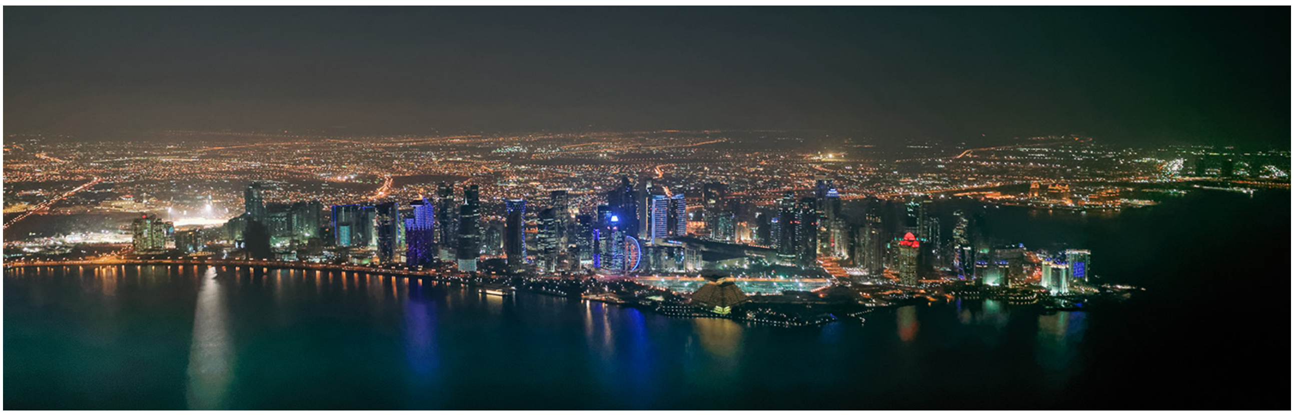


Figure 29: Aerial view of Doha waterfront. Courtesy of Jon Bowles photography

Chapter 3: Precedents

3.1 City planning

The concept of perfect living in city planning has been a utopia chased by architects and planners throughout history. As early as 500 B.C., the planning of the Roman city aimed for a socially integrated community. From the plug-in city, a visionary concept by Archigram designed in 1964, which believed in a hybrid flexible community, to Masdar City in Abu Dhabi, designed by Norman Foster, which plans for a carbon zero community in the age of global warming.

Cities deal with many changes, such as increasing population and building density, and excess usage of cars. A range of available technological possibilities also present their own challenges, making it difficult to achieve the anticipated goals of the planning sector and construction industry, because by the time their outcomes are achieved, unforeseen problems have usually occurred. In other words, many swift, fluctuating changes are occurring at the time of planning a city—and even after building the city, more flexible strategies are required.

Flexibility is thus a key issue. To meet the speedy social, economical, and technological changes as well as maintain city planning goals, cities have to be adaptable to change. This means that a city can respond instantly to the many changes if its components are flexible enough to interact with these changes. This is one of the key issues which this thesis addresses.

Figure 30: Masterplan of Masdar City.

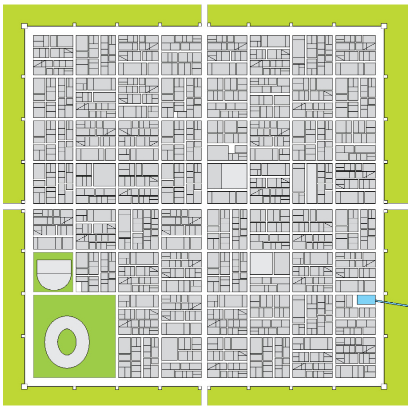


Figure 31: Roman City, 500 B.C.

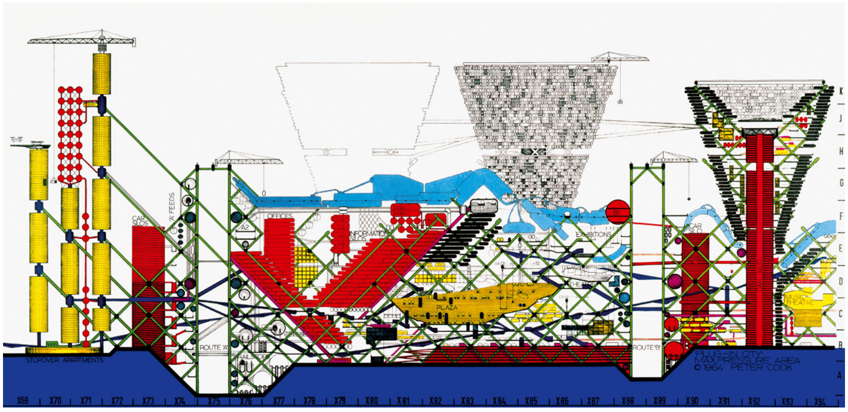


Figure 32: Plug- in City, Maximum Pressure Area Section, *Source:* Archigram, 1964.

3.2 Precedents on Flexible Architecture

3.2.1 Archigram's The Walking city

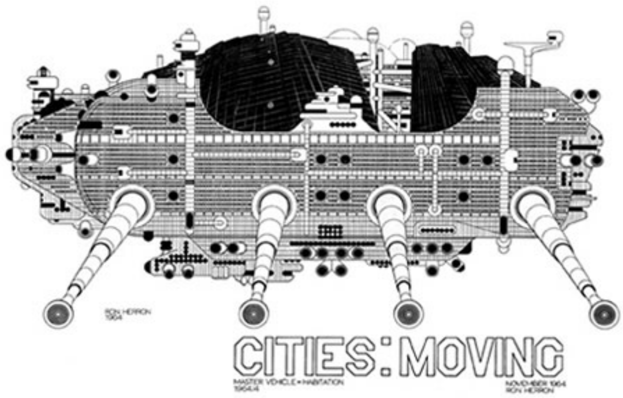


Figure 33: Design of Walking city unit design with telescopic legs.

In 1963, the London based Archigram group proposed a futuristic utopian vision for a flexible community, known as the Walking City, with nomadism as the dominant lifestyle. The walking city was a monumental image of mechanized urban centers that could carry whole societies to any point in the world on telescoping legs.

The project was a visionary idea for an existing modern nomadic lifestyle, but it overlooked a step-by-step plan and thus failed to indicate how the concept could become a reality. It did not discuss how existing technologies might be employed on its development nor did it include information related to budgets. In order to realize such visionary concepts, a focus must be on context, costs, and feasibility in terms of time.

Figure 34: A drawing of Walking city roaming in New York City.

3.2.2 Burning Man Fesitval

The burning man festival is an event which takes place annually in the Nevada desert in the states. It is a platform for the performing arts including music, art and drama. It last for one week and during that time, an entire city is created and then completely dismantled.

Many visitors live in tents and vans during their stay. Large temporary structures are assembled to host a range of activities. The city accommodates visitors and performing artists which reach tens of thousands. To aid navigation, a road system is created.

When the festival ends, the temporary city is dismantled without a trace. There is mutual respect for the environment. This is a positive model for a possible flexible community.

Figure 35: Burning Man festival layout.

Figure 36: The temple structure.

Figure 37: Trojan Horse.

Figure 38: Aerial view of Burning Man festival city.

3.2.3 Toyota Housing, From cars to dwellings

The Toyota company, probably best known as a car manufacturer, owns a modular house building system development in Japan. [39] The company uses its car manufacturing technology to develop earthquake-resistant homes. The structures takes 45 days to build with lifespan of 60 years. [40] This is twice the average lifespan of a home in Japan. House modules are being developed with cooperation with the client. All the components in the house are itemized using a special computer program to calculate the cost. A variety of materials and finishes can be used with variable layouts based on client needs. This is an example of how technologies developed in one industry can be successfully adapted for use elsewhere.

Speed, accuracy and mass production are the main fundamental characteristics of car manufacturing technology. Here they are applied in housing sector. In Japan where earthquakes are a constant threat, there is a need to be able to construct homes with speed and accuracy and also economically. It is this problem which Toyota is working to solve through applying the car manufacturing process to that of successfully building homes.

Figure 39: Toyota prefab steel construction house Prototype, Render.

Figure 40: Toyota prefab steel construction house Prototype, Render.

Figure 41: Toyota prefab steel construction house Prototype, Render.

3.3 Ultimate Flexibility is living on water

Flexibility can only be realized if there is an ability to reconfigure the urban environment in response to the way the environment itself is constantly changing influx. These changes occur on two levels, the way the city must itself change to the changes occurring in society. Water, by its characteristics, can provide the ultimate level of flexibility, as the ability to move, orient, and dismantle buildings can be much easier on water than on land. To understand the concept of living on water as an alternative for future urban extension, a study of floating vernacular communities, visionary ideas, and modern floating structures has been made to analyze the pros and cons of each prototype. The study will help find a new and refined realistic vision to be adopted to combat climate change, urban expansion, and rapid population growth.

3.3.1 Makoko Floating Village A vernacular community on water

The project designed by architect Kunle Adeyemi for the Makoko community proposed to improve the slum conditions in Lagos, Nigeria. [41] Although the usual approach to the floating shanties in Lagos is to build on stilts, this project introduced a floating school based on 256 used plastic drums, constructed by locally sourced wood. The sustainable project uses solar panels as a renewable source of energy and rainwater harvesting, and also provides sanitation, which is a rare amenity in the settlement, as noted by Adeyemi, who also believed that building on water is cheaper than building on land. [42]

Because Makoko is a coastal city, an innovative solution has been used to adapt with the rising floodwater, through a technique by the Japanese company Air Danshin Systems, [43] which is similar to earthquake proofing technology. Sensors in the floating structure detect environmental change and activate a compressor that creates a cushion of air at the base of the house in order to protect the inhabitants.

Unfortunately, the project has been outlawed by the Lagos state government despite the fact that Lagos is one of the world's fast expanding 'megacities' [44]. The city is facing a rising housing demand due to the growing population. The Makoko project address many aspects facing coastal cities from rapid expansion, housing shortages, and energy needs. Makoko community project clearly shows the future possibilities of how we might use the notion of living on water. With already present technologies, the idea of living on water could become more acceptable on a wider global range.

Figure 42: An aerial view of the waterfront community in Lagos

Figure 43: An aerial view of Makoko floating school within the context of the waterfront community in Lagos

Figure 44: Makoko floating school timber structure.

Figure 45: A floating foundation of plastic drums.

Figure 46: Boats are used for transportation.

Living on water can come to light as an alternative of living on land if the idea is placed in more ready and willing contexts.

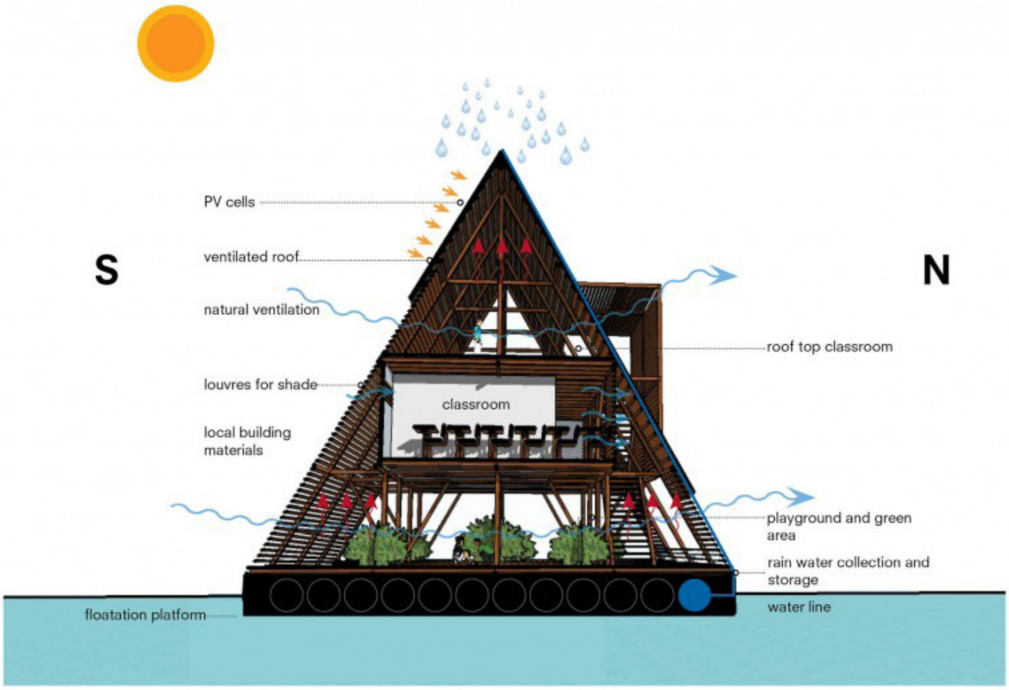


Figure 47: A section showing the design of the sustinable floating school

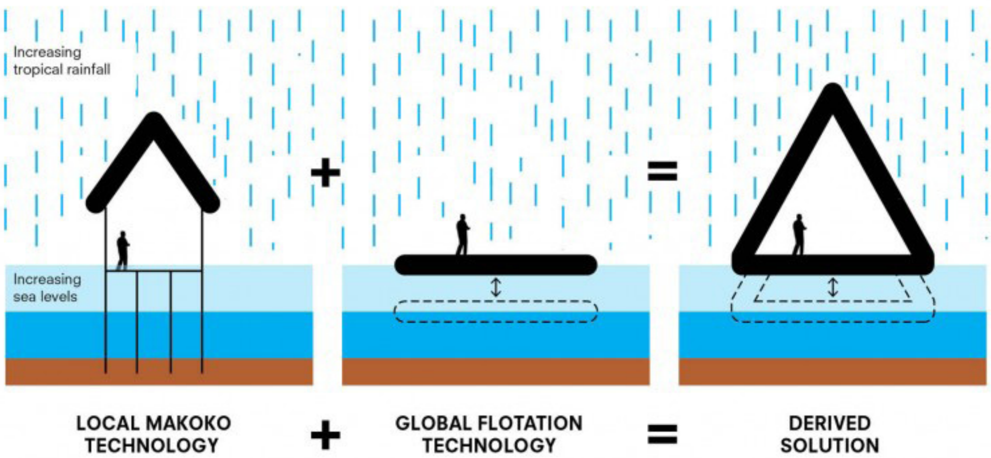


Figure 48: A drawing showing the solution derived from integrating the local building technology with global floating technology.

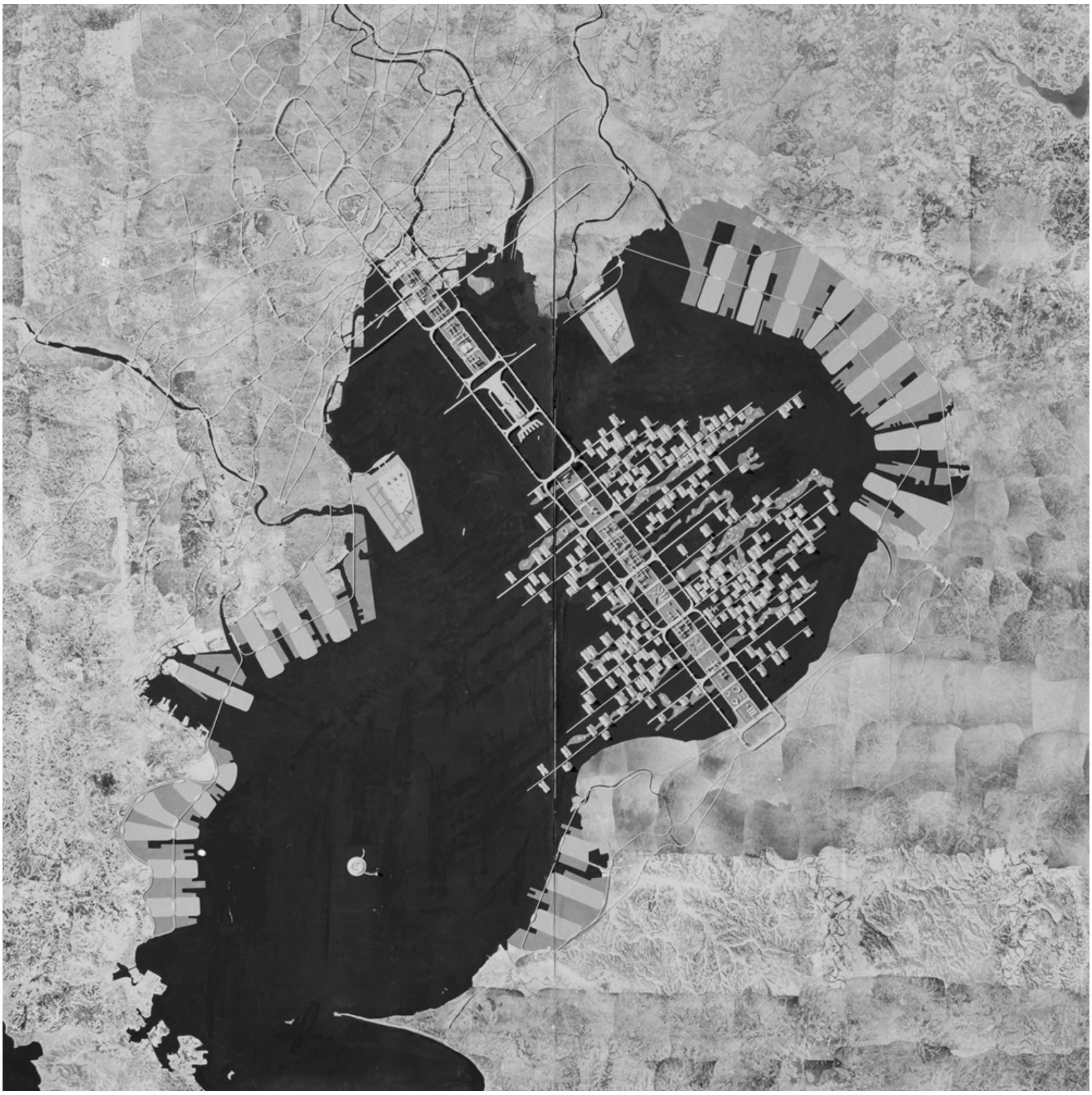


Figure 49: Kenzo Tange masterplan for Tokyo 1960

In 1960, Architect Kenzo Tange proposed a new spatial order for the city of Tokyo. The city had reached the height of urban sprawl with a shortage of space and old physical structures trying to cope with the rate of expansion. To accommodate the city's expansion, Tange proposed extending the urban fabric into the bay through a mesh of gigantic structures capable of housing more than 10 million people. [45] The design features a linear series of inter-locking loops, which spread across the bay, and uses water as a flexible component of urban expansion. However, the project was a utopian idea that has never been realized.

3.3.3 Flooded London 2030 A visionary Ideas for Living on water

Flooded London is a thesis work proposed by Anthony Lau in 2008 at the Berlet school of Architecture, the proposal discusses the urbanism of the river Thames Estuary in 2030 when rising seas levels will be a threat to the land, thus creating the need for more land [46].

The design gives new life to decommissioned ships and oil platforms by converting them into hybrid homes adapted for aquatic building. Lau believes that most modern floating architecture involves new-build modular systems for mass production that lack character, although they may be the most sufficient for space planning. The multitude of hull shapes and sizes can inspire unique and inventive design, and the proposal aims to express the forms and internal steel structures of hulls by utilizing the flooded landscape, a floating city of offshore communities, mobile infrastructure, and aquatic transport. This will allow the city to reconfigure through fluid urban planning. Wave, tidal, and wind energy will be ideal for this offshore city and the inhabitants will live alongside the natural cycles of nature and the rhythms of the river and tides. Lau added that the strategy for creating a self-sufficient floating city by reusing ships and marine structures can also be applied to island nations, such as Maldives [47].

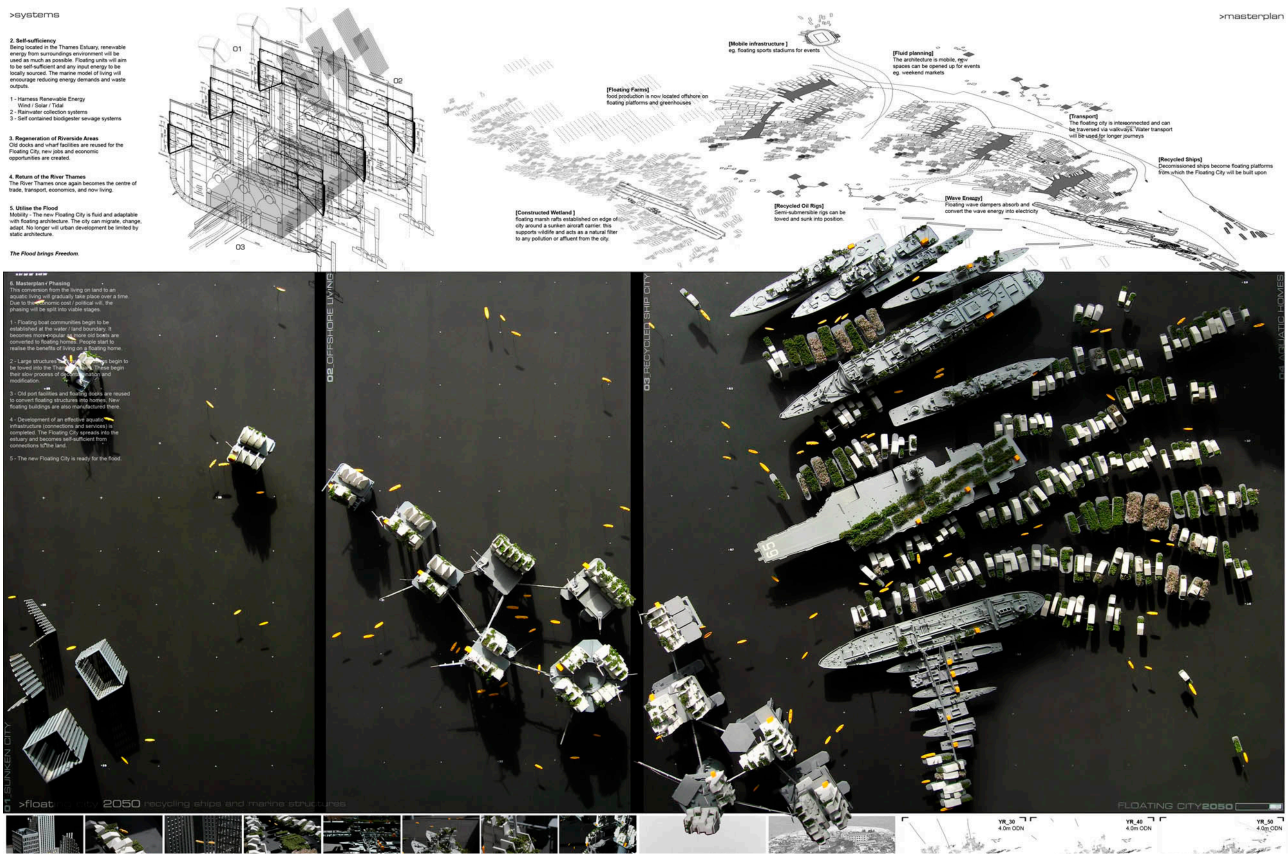


Figure 50: Layout of Floating city, 2030.

Figure 51: A collage image of Lilypad islands at Doha waterfront, designed by the author.

Figure 52: A render shot of roaming Lilypad floating islands.

Figure 53: The Lilypad design was inspired from the waterlily plant.

The project was designed by architect Vincent Callebaut as isolated seaside shelters dedicated to climate refugees. The floating community is planned to host 50,000 inhabitants [48]. Depending on renewable energy technologies, including solar, thermal, wind, tidal, and biomass to produce more energy than it consumes, Lilypad is to be a self-sufficient floating city. The project is designed for daily life activities rather than for luxury lifestyle.

Lilypad is a futuristic vision which the designer hopes becomes a reality in 2100; however, the cost of one floating city for 50,000 inhabitants would be enormously expensive. Moreover, in times of catastrophic events, Lilypad could only accommodate a limited number of inhabitants, leaving others without protection.

3.3.5 Waterwoningen

A floating community in the Netherlands

A successful example of a floating community is a project called Waterwoningen by Marlis Rohmer in 2011. The project is located in the Netherlands where house boats used to compensate for the lack of land in this country which is largely reclaimed from the sea. [49]

The community contains 55 floating units, being constructed in a shipyard and towed by tug boats to site. Houses are supported by a concrete hub submerged in water to a depth of half a story. Constructed from light weight structure, the flexible module system can be adapted to accommodate individual requirements. Portable units are connected to the main supplies of water, heat and electricity. In summer, inhabitants can enjoy water activities around the house. In winter, water freezes and becomes a terrain for skating and other activities.

Figure 54: Aerial view of floating houses showing bridges network

Figure 55: An aerial view of the floating houses.

Figure 56: A floating house being towed into position. Houses are constructed in a shipyard and floated to site.

Figure 57: In summer, inhabitants can enjoy water activities.

Figure 58: In winter, water froze and become a terrain for skating

Figure 59: The picture shows houses constructed on pillars on the right and totally floating houses on the left.

Precedents of adapting vernacular cooling architectural techniques in hot climates

Considering that, this thesis is focusing on studying the possibilities of using water as a platform for future urban expansion. Dealing with hot weather climates such as Qatar, is a key issue in the designed project and a challenge that has to be overcome . The following precedents will briefly focus on the work of the Egyptian architect, Hassan Fathy, showing varies techniques used to generate thermal comfort houses.

The drawings will focus on understanding the techniques of clustering, aerodynamics, shading and passive cooling used by in buildings designed by Hassan Fathy. He used to classify spaces to private spaces, semi private spaces, in the form of outer courts and inclined entrance and public spaces. This helped controlling the temperature on microclimatic scale and also was convenient for the community culture. The work of Hassan Fathy was considering sustainability in terms of thermal efficiency, costs and energy efficiency and encouraged user participation in his design process.

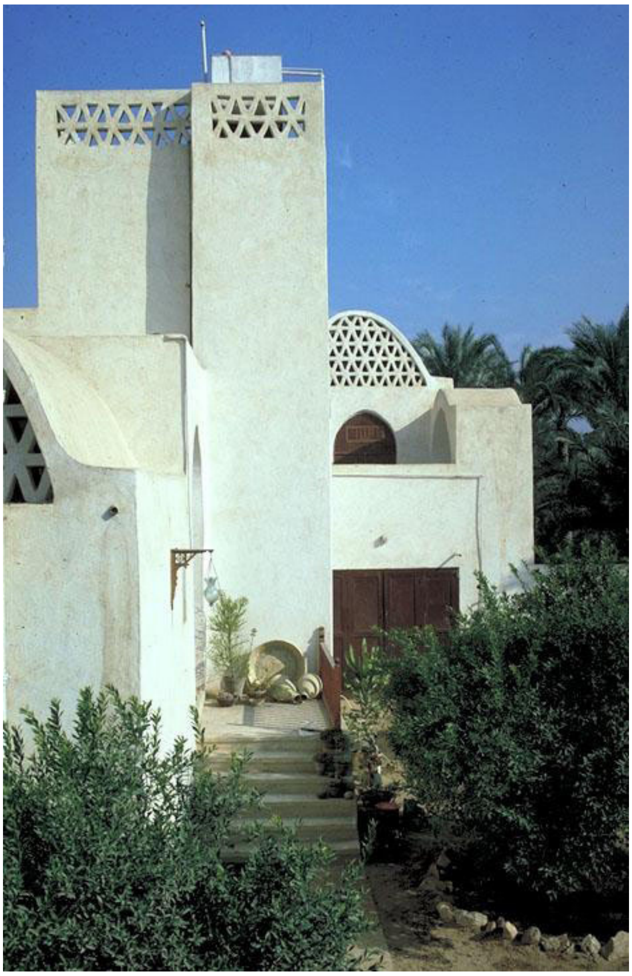


Figure 60: Akil Sami House design by Hassan Fathy

Clustering

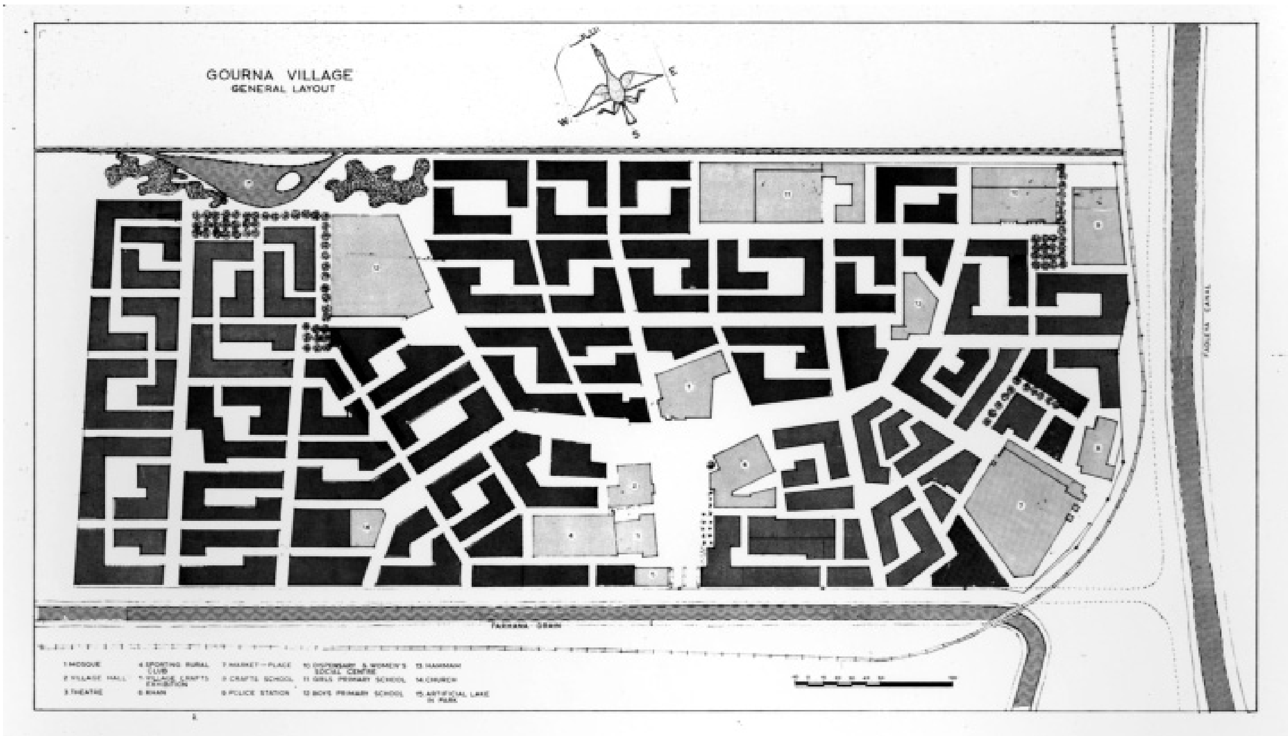


Figure 61: Al Gourna Village master plan

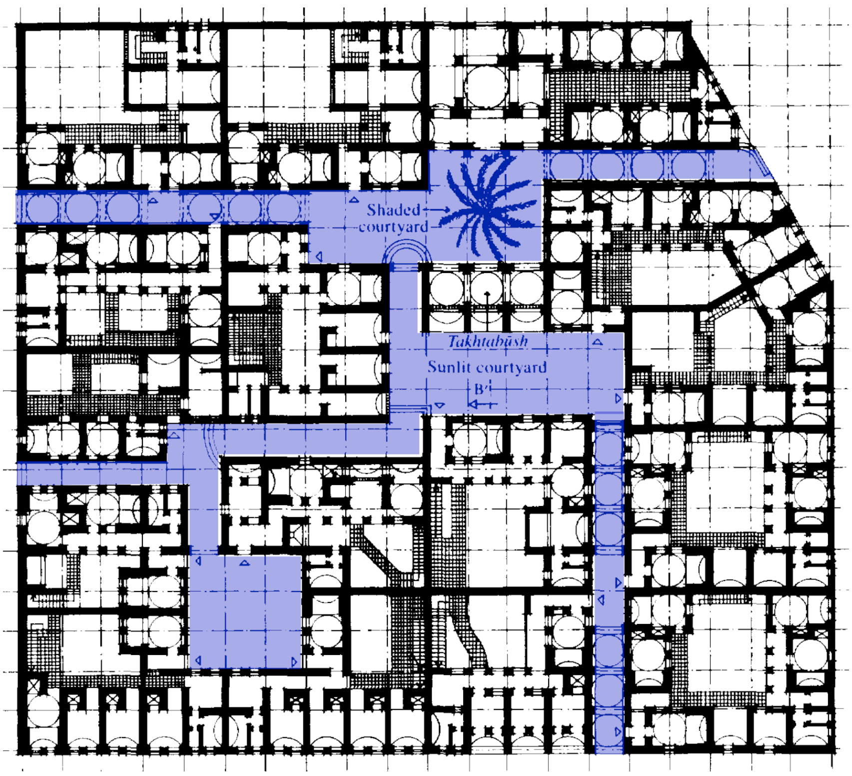


Figure 62: Plan of a part of the village of Bāris, Al-Khārga Oasis, Egypt.

Neighborhood clustering

Fathy used clustering techniques to create courts, intermediate spaces between public and private spaces. The short distances between buildings is used as an advantage to shade the narrow streets, and controlling light exposure to decrease the amount of surfaces exposed to heat. While the courtyards serving as reservoir of cool fresh air. The relation between the narrow streets and the courtyards ensures a steady flow of air. The microclimate of the layout is affected by the topography and the configuration of the layout components.

Shading

Claustra are lattice vents, used to evacuate the hot air collected in the higher parts of the room to achieve uniform distribution of air flow, blocking direct solar rays and decoration. (50)

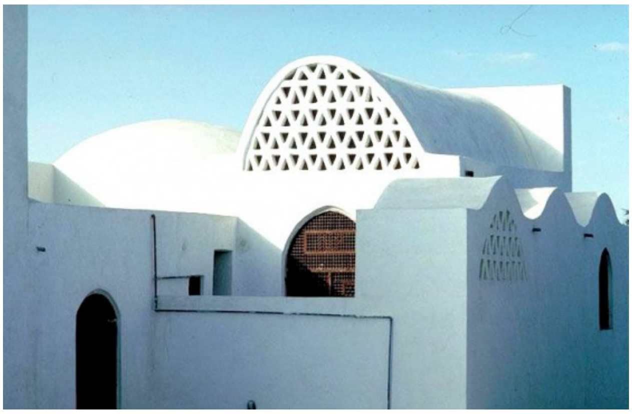


Figure 63: Claustra in Akil Sami house, designed by Fathy

Mashrabiya is a wooden lattice screen used to control the passage of light, control the air flow, reducing the temperature of the air current, increasing humidity of the air current and ensuring privacy. (51)

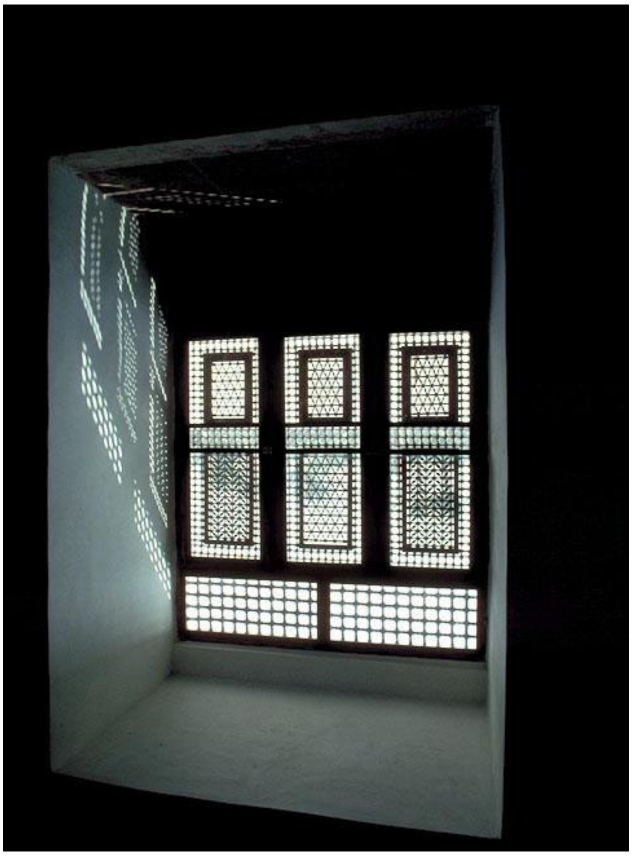


Figure 64: Mahrabiya installed in Akil Sami house designed by Fathy

Aerodynamics

Controlling light, ventilation and view with ordinary window is a difficult task. To achieve ventilation, windows have to be small which reduce space lighting. To provide sufficient lighting for space, windows have to be bigger which increase the amount of heat gain.

To solve that, the malgaf was invented. It is a shaft located above the building with an opening facing the prevailing wind to trap the wind from high above the building and channel it down to the interior of the building. (52)

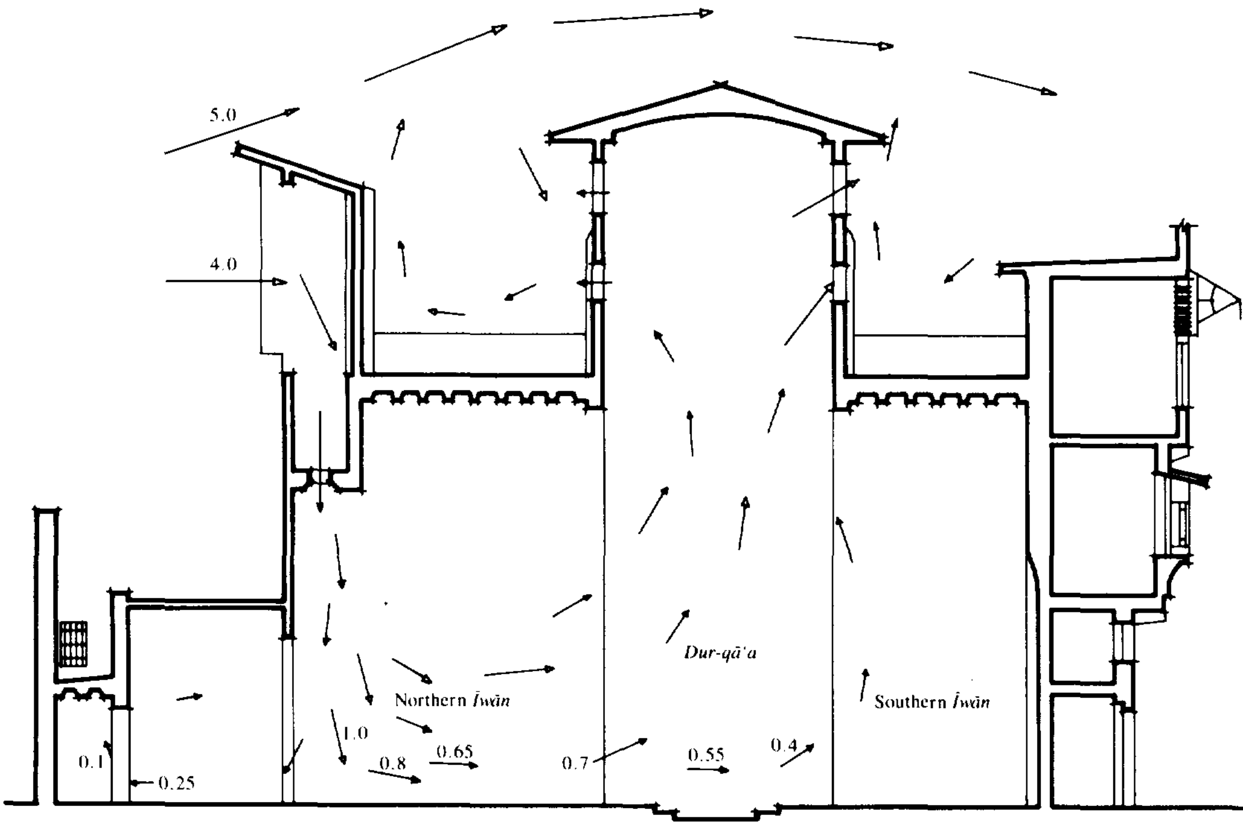


Figure 65:Section showing the malgaf producing internal air movement. Arrows indicate the direction of airflow; arrow length corresponds to airspeed.

3.4 Findings

Although the concept of ambitious mega-structures such as Archigram or Lilypad may provide an aesthetic value when attached to cities' waterfronts, they lack momentum, and there is no urgent demand for these ideas to be realized because they are too expensive and would take years to be accomplished. In order to realize these visionary mega plans, they must be economically accepted in terms of cost and time.

In order to adapt to the rapid changes that face cities, the response should be quick enough to accommodate these changes. If a city is facing a dramatic population increase such as in Qatar, or turning to a touristic or industrial mega-region, provision should be met as soon as it is needed, not beyond the event.

Despite a project like Makoko floating school is being convenient to the local context of Lagos. It is doubtful it would prove successful in developed nations where living conditions and requirements are completely different. There is no structured framework that can make the floating community independent from the city.

Though precedents showed diversity and different ways to approach water as an alternative for living, a structured vision needs to be adopted to implement the use of water as fabric for future extension. In the next chapter, I intend to propose a flexible framework that can be applied in more than one place using current technologies.

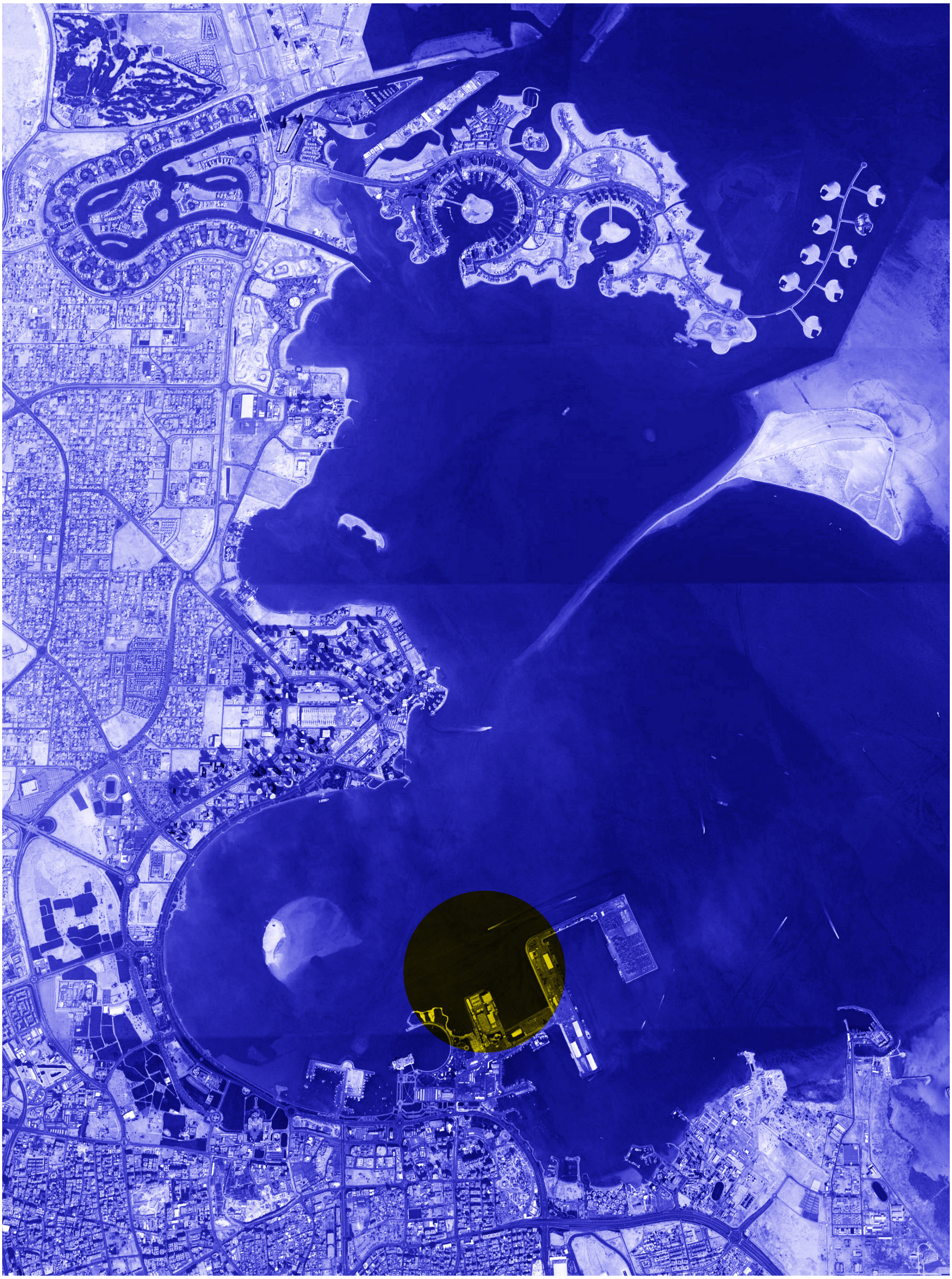


Figure 66: A satellite image of Doha waterfront showing the proposed location for the transient community near the Museum of Islamic Art.

4.1 Management of Doha waterfront

As previously mentioned in Chapter Two, Qatar is working to promote its waterfront as the predominant image of Qatar and the heart of the city where heritage meets the future. The waterfront holds great importance as a global image of Qatar to be established in the time of the World Cup 2022. Guy Debord affirms the importance of the visual image of cities in his book, the *Society of the Spectacle*. He states that "just as early industrial capitalism moved the focus of existence from being to having, post-industrial culture has moved that focus from having to appearing." (53)

The automobile oriented way in which the waterfront is currently being used prevents the inhabitants from taking advantage of living in a coastal city. A strip of walkway with few activities is attached to the automobile road connecting the city's main facilities from the airport to the pearl island.

As an expatriate living in Doha city, I believe that people who are visiting for job opportunities, business, and tourism are usually willing to live in more integrated hyperactive areas in the city. Doha waterfront is viewed as the center and the gateway of the city, connecting diverse activities for business and leisure, and a place of interaction for people with different socio-economic cultural backgrounds seeking a new life experience. It is also considered to be the site where past, present, and future converge. It is the location of the historical pearling industry and the new Museum of Islamic Art—a modern structure with ancient treasures—and an area of Souq trade and international commerce. Adding to that, the rising need of housing for expatriates and tourists presents water as an opportunity for urban expansion and an interesting place for expatriates and visitors to be located at the center of the city.

Choosing location

As this project presents a flexible framework that can be applied to any city with a waterfront, the location of Doha was chosen because of the importance of the place and visionary plans for the city: a short distance from the Museum of Islamic Arts and new Doha airport. This location has many benefits of being near to all future transportation hubs, such as Doha Metro network, and provides a great view of the city skyline.

4.2 Inspirations

4.2.1 QR Code

Quick response (QR) code is a machine-readable code consisting of an array of black and white squares used to access websites or other information.

Although QR codes seem similar, each one is uniquely programmed to recognize a certain type of content. The location of the black and white squares within the code and the relation between each square to another forms a variety of configurations that differentiate each code from another, despite the specific dimension of the square framing the code, and the defined dimensions of the black and white squares.

The design concept behind the transient community is inspired from the QR code, which is based on standardizing mainframe work components. It maintains flexible configurations that will distinguish every design of every floating community.

Figure 67: Three seemingly identical QR codes with the same outer dimensions but that differ on the inside.

4.2.2 Water lilies

The water lily is an ornamental aquatic plant with large, floating cup-shaped leaves. Their natural dynamic formations inspired the design of the transient community.

Figure 68: Natural dynamic formation of water Lilies.

4.3 Design Concept

The project explores using water for expanding urban fabric through a framework that can be applied in many locations with various configurations. The project consists of three main components that form the framework of the transient community. They are:

1- Floating units

2- Semi-floating nodes

3- Pedestrian bridges

Each semi-floating node acts as a hub for the flexible framework, as a supplier, and as stabilizer for the floating units. Each node is fixed by a skew-supporting axis to an underwater network. The underwater network is a grid of pipelines supplying the semi-floating node with electricity, fresh water, sanitation and internet. Each node has a solar tower to generate electricity and provide lighting at night. Solar towers can be colored to act as landmarks for inhabitants who roam around the community, and each node can be named by letters and numbers to be easily identified, as in the case of the Burning Man festival previously discussed in Chapter Three.

The floating unit, with a variety of dimensions and prototypes to fit in between the nodes, is where the inhabitants live. House designs on the floating units vary depending on the environment, weather, culture of the inhabitants, and level of luxury. Some of the floating units can be used as gardens and gathering areas for the neighborhoods. Each unit is attached to a semi-floating node and linked by a floating pedestrian bridge.

Floating bridges work as a street network to the tran- sient community. Bridges are connected to a predefined permanent floating main axis, which is connected to permanent facilities and through it to the land. The main axis of the city is necessary for any transient community, as it can be used for emergencies, ambulances, and evacuation. Units existing around the main axis are permanent floating units for long-term inhabitants. Others are hybrid, changing their location through a hybrid system. Depending on the number of inhabitants living in the community and the scale of the terrain the community occupies, more than one axis can exist.

The project is mainly designed for expatriates with short and long stays, World Cup tourists, and residents interested in living a unique lifestyle on water and in the heart of the city. Through many designed prototypes and designs which vary between studios, apartments, and both small and large houses with different floor dimensions and number of bedrooms, inhabitants can chose the most appropriate unit for rent or investment. The project is planned to answer the needs for rapid urban expansion, as it can act immediately by providing emergency housing units for the increasing population.

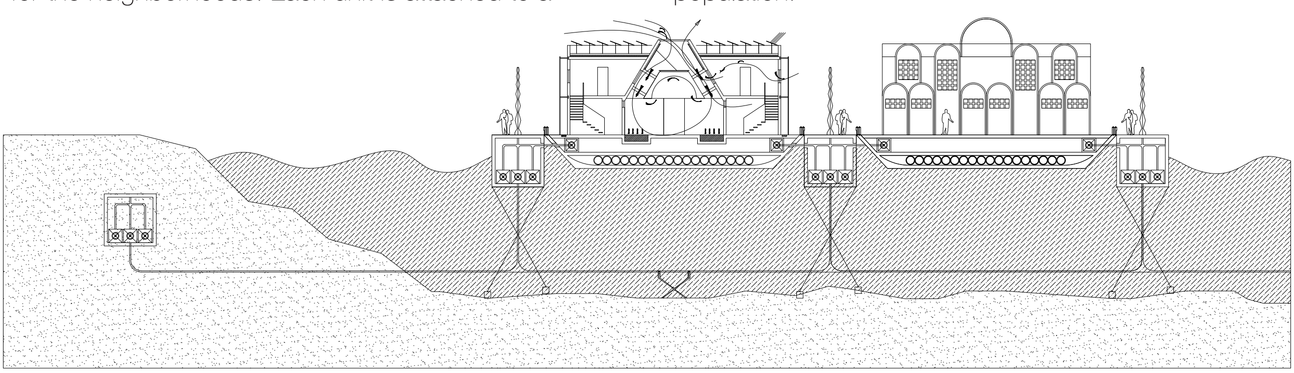


Figure 69: A section showing semi-floating nodes connected to underwater foundations.

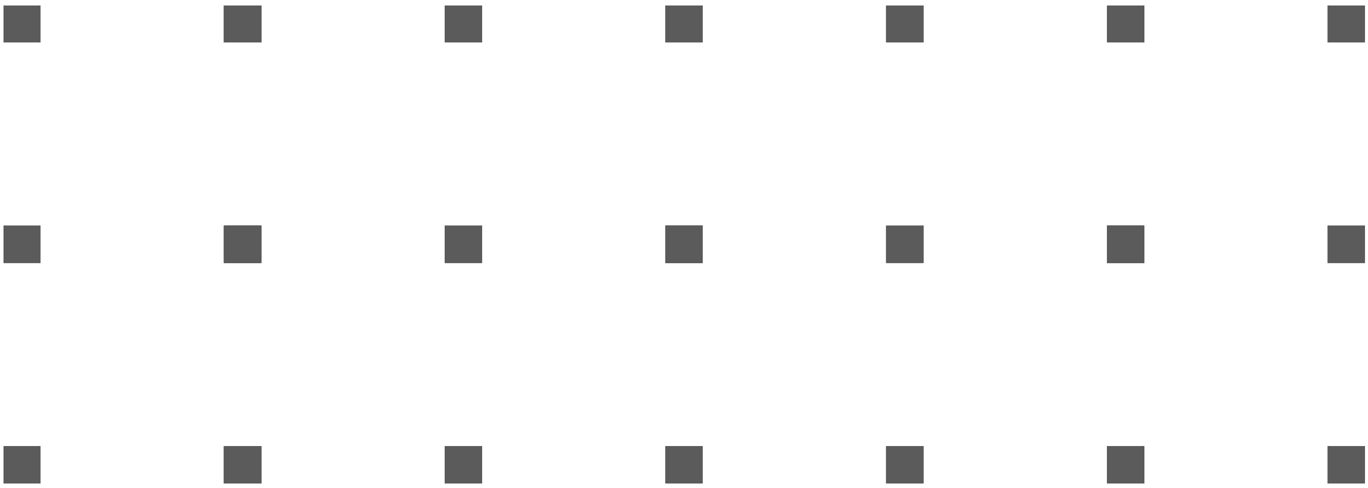


Figure 70: Semi-floating nodes grid with dimensions of 3.6*3.6 meters distributed every 20 meters, supplying the community with necessary facilities.

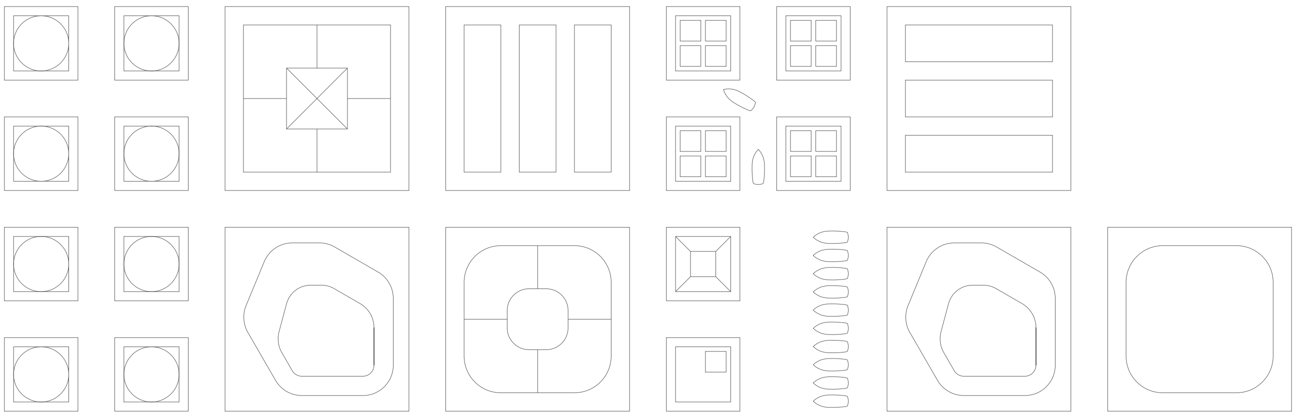


Figure 71: Floating units with different prototypes inside the proposed grid.

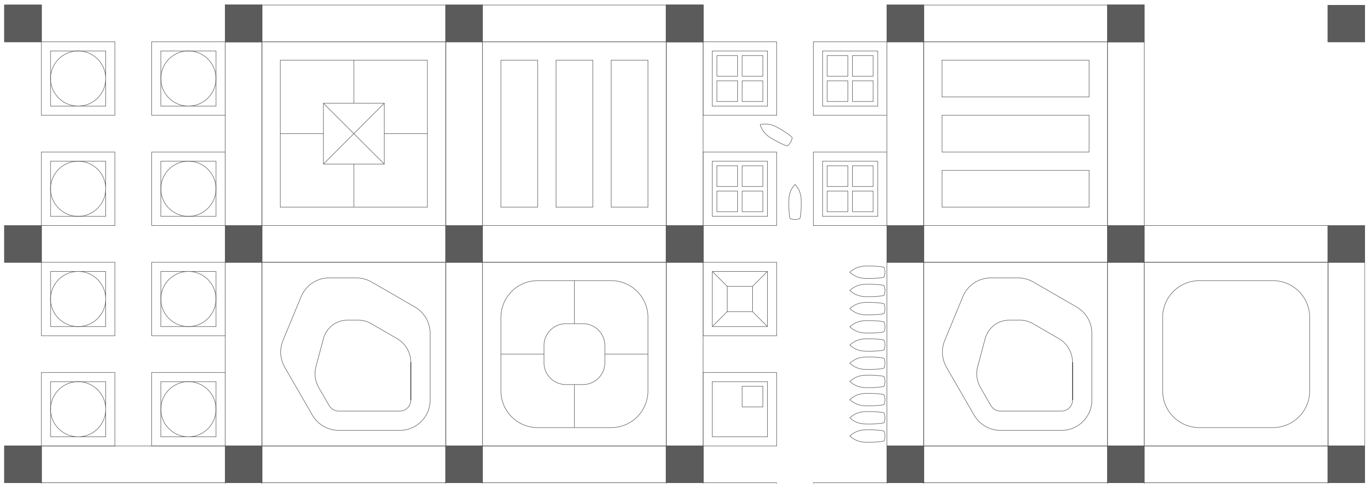


Figure 72: The interconnections of the semi floating nodes and the bridges form the walkway streets inside the community.

4.4 How transient community floats

Although the proposed design uses concrete as a foundation for the floating units, in addition to the use of lightweight steel structures and other materials, the designed units are meant to be entirely afloat without any pillars to the ground.

According to Archimedes, floating units can float on water like any ship if the weigh of water displaced is more than the weight of the object. However, the weight of concrete and steel is much heavier than the weight of water. Here is where the shape and dimensions of the floating units play an important rule to determine if the object will float or not. If the foundation is shaped in such a way that displaces more than its weigh, then it will float.

Using concrete as a floating structure:
Each year the American Society of Civil Engineers announces the National Concrete Canoe Competition, which provides civil engineering students an opportunity to gain practical experience by working with concrete mix designs. (54) The competition aims to develop lightweight floating concrete through using different mixtures to win the races. The competition reflects the importance of developing concrete as the most widely used building material in the world. To decrease the weight of floating foundations, expanded polystyrene,

Figure 73: Musheireb floating knowledge center, Doha.

can be used inside the hull of the floating concrete foundation.

Building Materials:
Varieties of lightweight material can be used in the offshore production depending on user choice and surrounding environment, such as lightweight steel, timber, fabrics and tents.

Construction:
Concrete hulls can be constructed in shipyards to ensure quality control. Building structures can then be mounted on the concrete tubs. Each unit is towed by tugboats to the site and anchored to two mooring poles to maximize stability during its trip to the city.

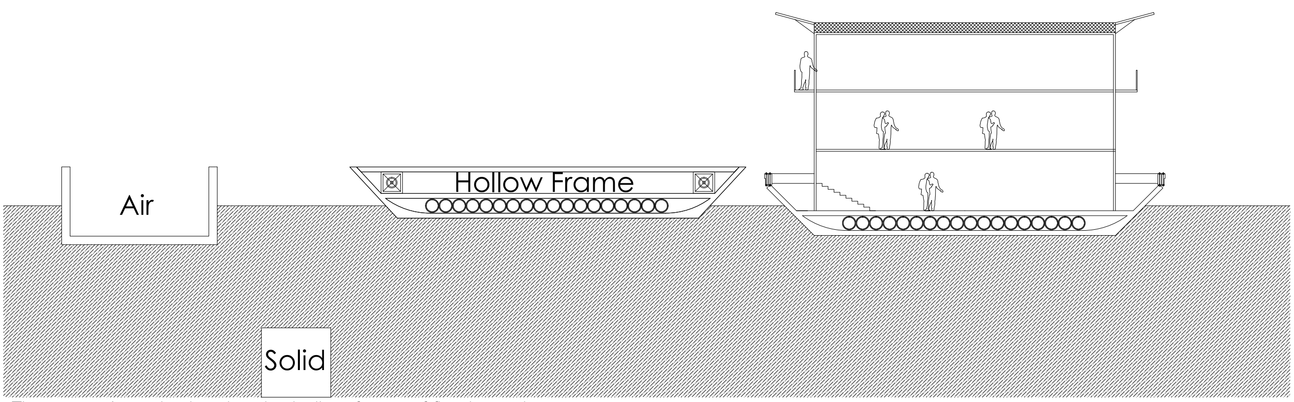


Figure 74: A study showing the hollow frame of floating units.

4.5 Semi-floating nodes

Today's technological advances on marine structures can combat the technical challenges of living on water. For a floating community, stability on water is a key issue. To assure stability, nodes are fixed by a mooring system to ensure stability under the worst weather conditions.

One of these systems is the SEAFLEX mooring system. (55) The mooring system uses polyester ropes under continual tension to provide horizontal stability to the floating nodes without the use of piles. The ropes end in rubber hawsers to handle water forces and are anchored to the seabed without causing seabed erosion.

A gap should exist between the floating units and the nodes to reduce frictions.

Another floating foundation company is IDEOL, which is developing offshore wind farms. (56) Thanks to hollow concrete structures, large wind farms can be constructed with reduced cost on a mass production level. Floating foundations can constructed onsite then towed by tugboats to their locations on water.
Hollow concrete structures are used in floating nodes and floating units to ensure long durability of the structures

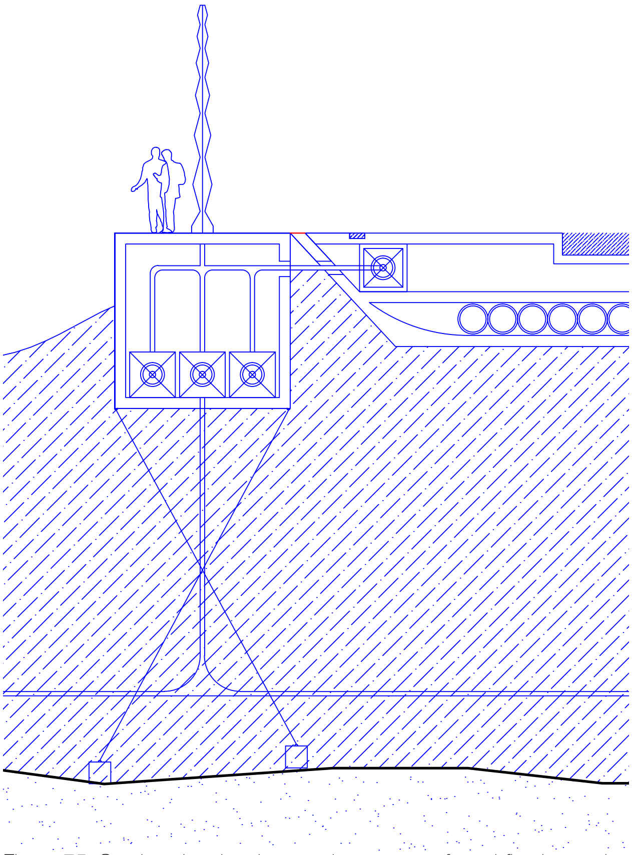


Figure 75: Section showing the mooring system of semi-floating nodes.

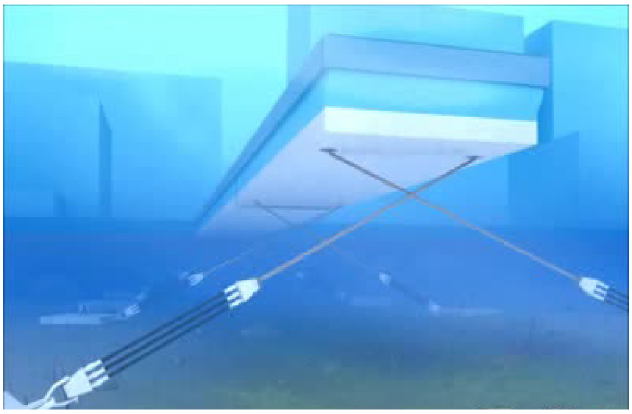


Figure 76: SEAFLEX mooring system.

Figure 77: IDEOL floating structure

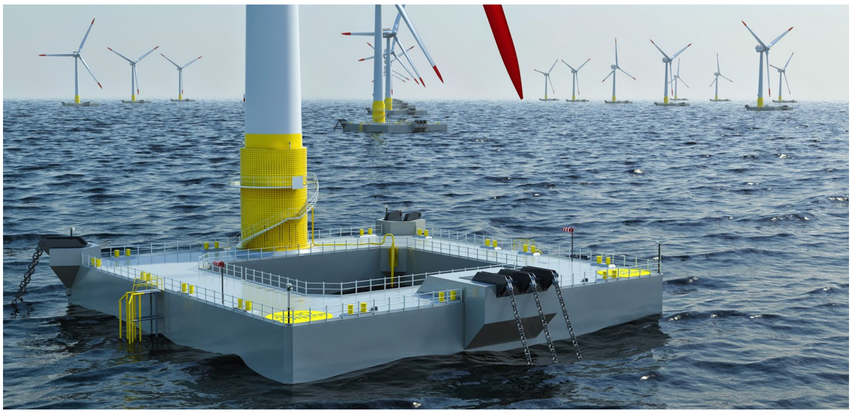


Figure 78: IDEOL floating wind farm.

4.6 Floating Structures

Floating units are the main components of the transient community. In this framework, three different prototype plots are presented to accommodate various inhabitants' needs. These plots are:

1- 20 m*20 m (400 m^2) accommodating between 8 to 16 inhabitants

2- 20 m* 8 m (160 m^2) accommodating 4 to 5 inhabitants

3- 8 m* 8 m (64 m^2) accommodating 2 inhabitants

Floating unit areas were determined to provide sufficient housing space and to match international standards of housing on land. However, these dimensions are flexible and to be reviewed when taking the project to construction level.

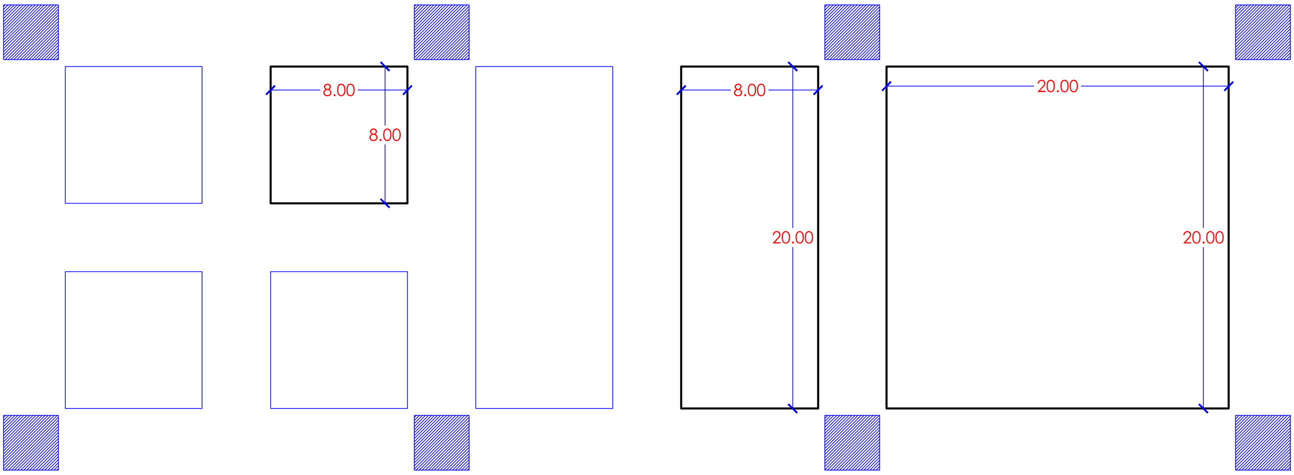


Figure 79: Three different floating prototypes.

In the proposed framework, the floating unit hull has a fixed design with predefined dimensions to be fitted within the nodes. Each floating unit can be connected to any of the floating nodes for water and electricity supplies. The structure of the floating unit hull is made of hollow concrete for durability and handling house weight.

The intervention on design for the floating hull was based on three things:

1- Reducing friction

2- Easy tugging

3- Easy orientation

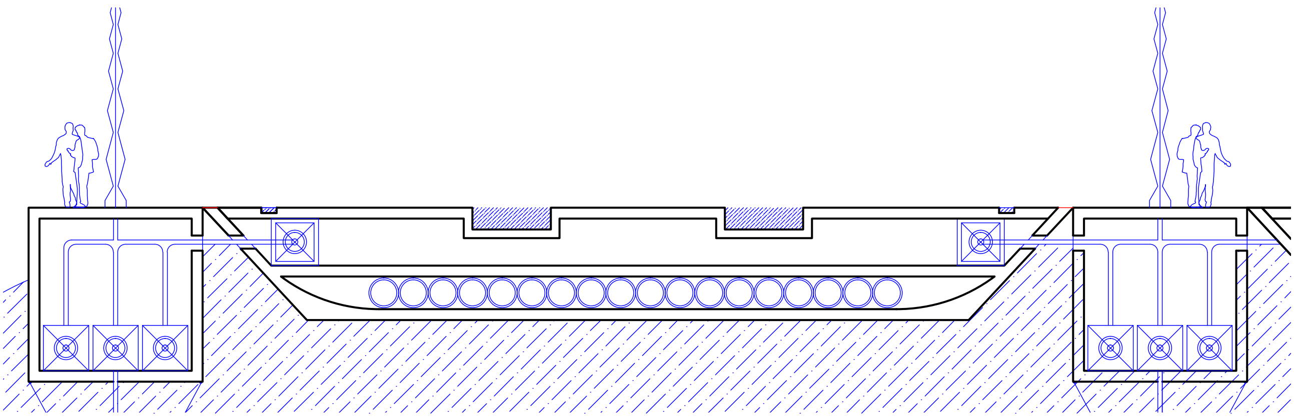


Figure 80: A section showing the supplying system between nodes and floating units.


Figure 81: Floating unit chamfered edge.

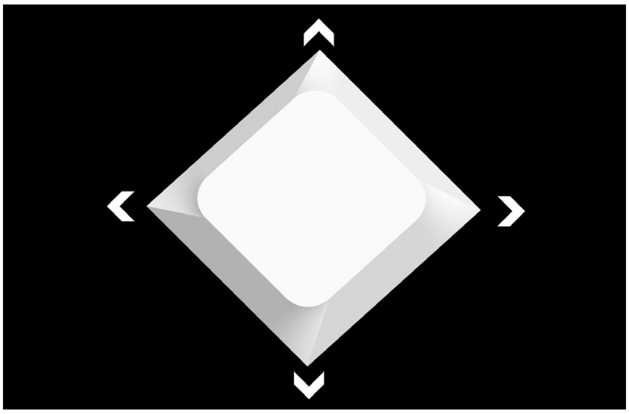


Figure 82: easy tugging design

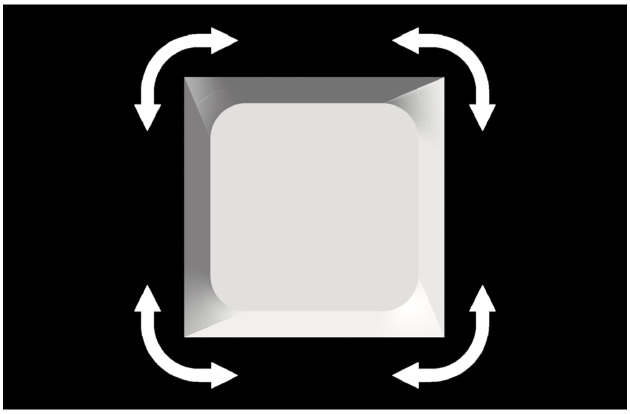


Figure 83: easy orientation design

To reduce friction between nodes and floating units, the edges of the hull are chamfered as shown in Fig 81. The chamfered edges reduce the contact surface between the nodes and the hulls and therefore reduce friction Another benefit of the chamfered edge is the easy penetration of water and therefore easy tugging. The four edges of the floating hull are identical to allow tugging from any direction.

To easily orient the unit in the floating community, the base of the hull is circular shaped to provide minimum rotation angle.

A prototype scaled 1:100 was fabricated using a 3D printing machine. The result was an actual floating plastic hull as seen in the picture. However, the design of the floating hull is the design's own interpretations without professional testing. The concrete floating hulls should be tested and examined by professionals in the field to achieve a final design form of the floating hull.

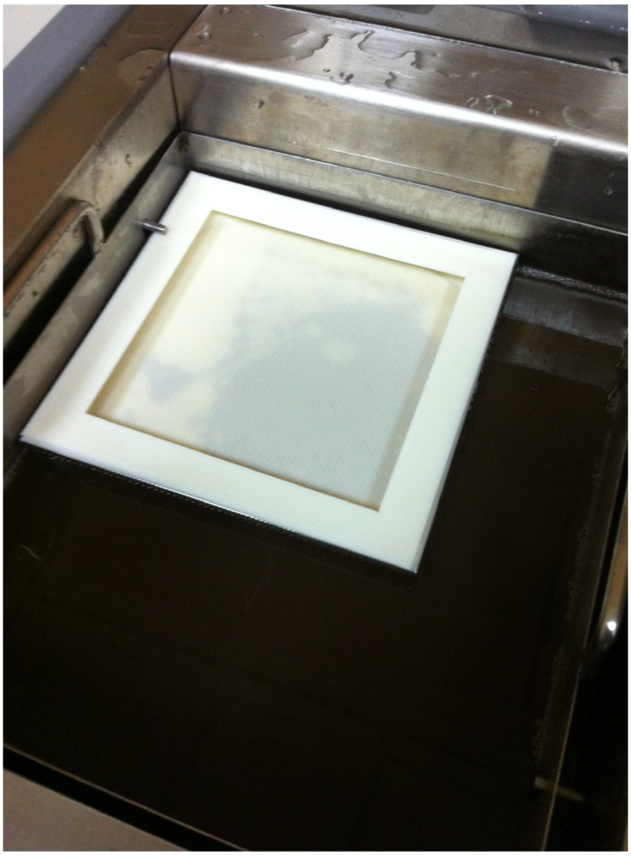


Figure 84: digital fabricated floating prototype.

4.7 Stability, dimensions and ratios

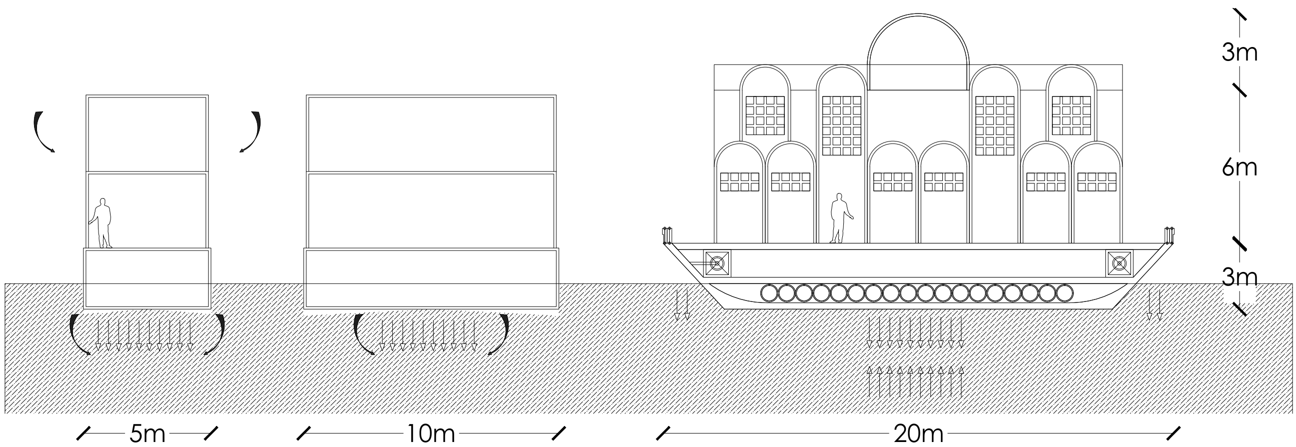
Although water provides a maximum level of flexibility, stability is a major concern when building on water. Floating units must be stable enough to reduce the continuous motion of the water waves and tide. This needs to be accurately calculated by experts within the context of water. However, In the thesis project, I will introduce general design guidelines that can be used to ensure stability on water.

Relation between height, width, and depth of building under water determines the stability of the floating unit. Depth can be assumed to be one story underwater for a housing floating unit with two stories, for a concrete foundation based on the precedent project in the Netherlands, Waterwoningen.

If the foundation of the building is relatively small to the height of the building, then it will be difficult to ensure stability with continuous water movement. This is the case with many floating boathouses in Ijburg, the Netherlands, following strict building regulations of a fixed plan of 7*10 m, which results in unstable houseboats [57] . The drawings below show the ratio between building height and width.

Connecting the floating units with bridges and with the semi-floating nodes increases the stability of the floating community, forming it into one large unit moving horizontally and vertically on water, and this in turn will reduce the movement on water.

Figure 85: A study showing different proportions of floating units.



4.8 Bridging

Floating bridges are the walkways for the transient community. They work as the streets in the city. To successfully achieve the reality of living on water as an extension of living on land, no compromises should be made on the inhabitants' safety. Thus, connecting floating units is a key issue. Because a transient hybrid community is adapted to a high level of flexibility, this requires some characteristics for floating bridges and the way they are connected to the nodes and the housing units. These characteristics are:

1- Floating bridges can be temporary or permanent depending on their locations in the transient community and on the inhabitants' needs; they must be completely afloat without any pillars to the seabed.

2- Floating bridges should provide an uninterrupted, continuous, and safe deck surface for pedestrians to ensure community connection through bridge networks, as well as hand railings and an overhead protection if needed to ensure human safety.

3- Bridges should be able to handle the weight of pedestrians living in the community

4- The ability to be stable with changing water levels. This requires a connection with floating nodes that are connected by tension wires to the seabed. Bridges can be moored to the floating nodes and the floating units to ensure a great level of stability on water. Gangways are used to connect the floating bridges with the floating units and the nodes to provide safe, continuous walkways.

5- With the continuous changes in the transient community, the hybrid activity of the floating units, and the

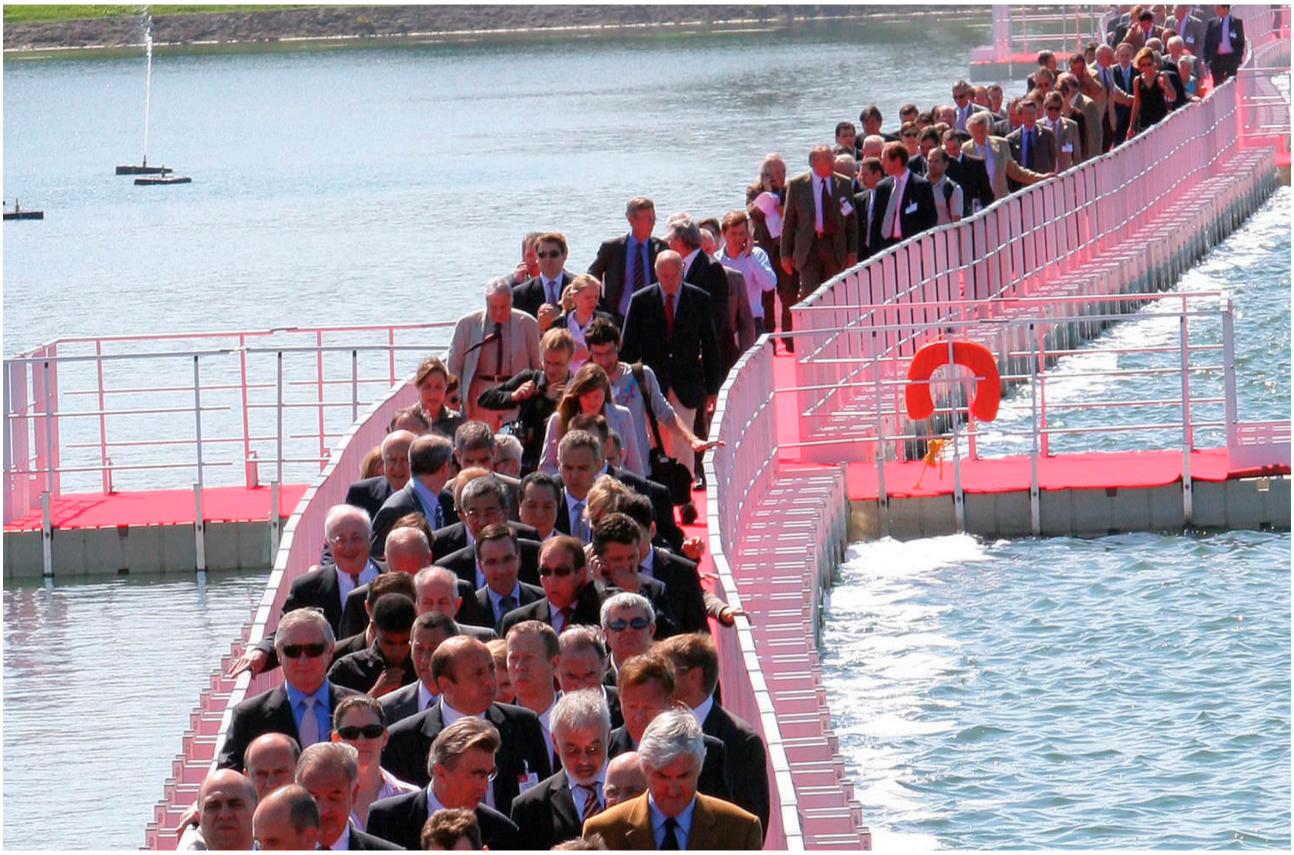


Figure 86: Floating bridge by EZ Dock.

ability to increase the number of units, bridging should be fast and easily accessible.

6- Bridges can be accessed by boats or by swim ladders from swimming pools.

7- Bridges can be easily unplugged from the floating units and towed by tugboats to move floating units or to disassemble the transient community for relocation.

Nowadays, with advanced technolgies, different types of floating bridges exist that can fit the requirement of the floating community. Two of these types are EZdock [58] and Surego mooring systems. Figures 86, 87, and 88 show an actual EZ dock system. These systems prove that living on water can exist in the current time.

Surego patented an innovative floating bridge solution that allows 30-degree sideways movement in horizontal directions. [59] This allows the walkway system to be applied in various configurations and with the flow of water. This system can be appropriate in some extreme weather conditions, which can fit with a different framework in another location, with the exclusion of floating nodes.

Figure 87: Floating pedestrian bridge by EZ Dock

Figure 88: a picture showing the endurance capabilities of EZdock floating bridges.

Figure 89: Suego flexible floating bridges.

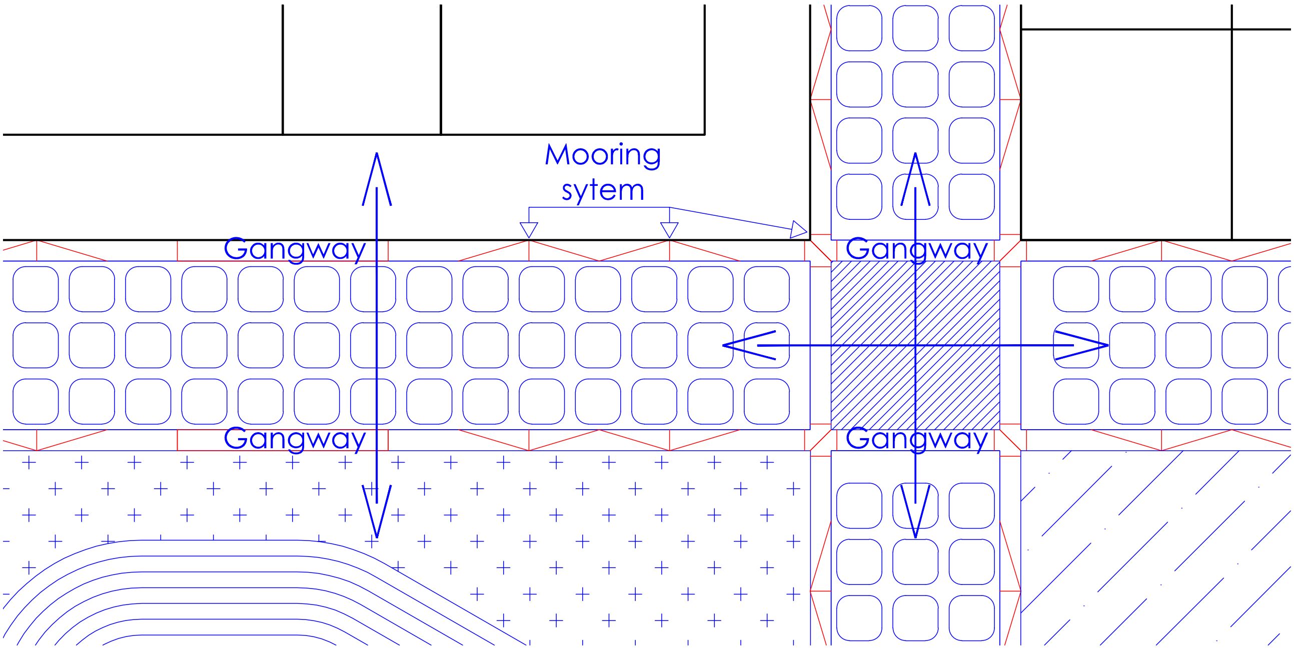


Figure 90: A diagram showing the using of gangways between units to ensure pedestrian safety


Figure 91: A picture showing a mooring system technique that can be used in the connecting floating units to nodes.

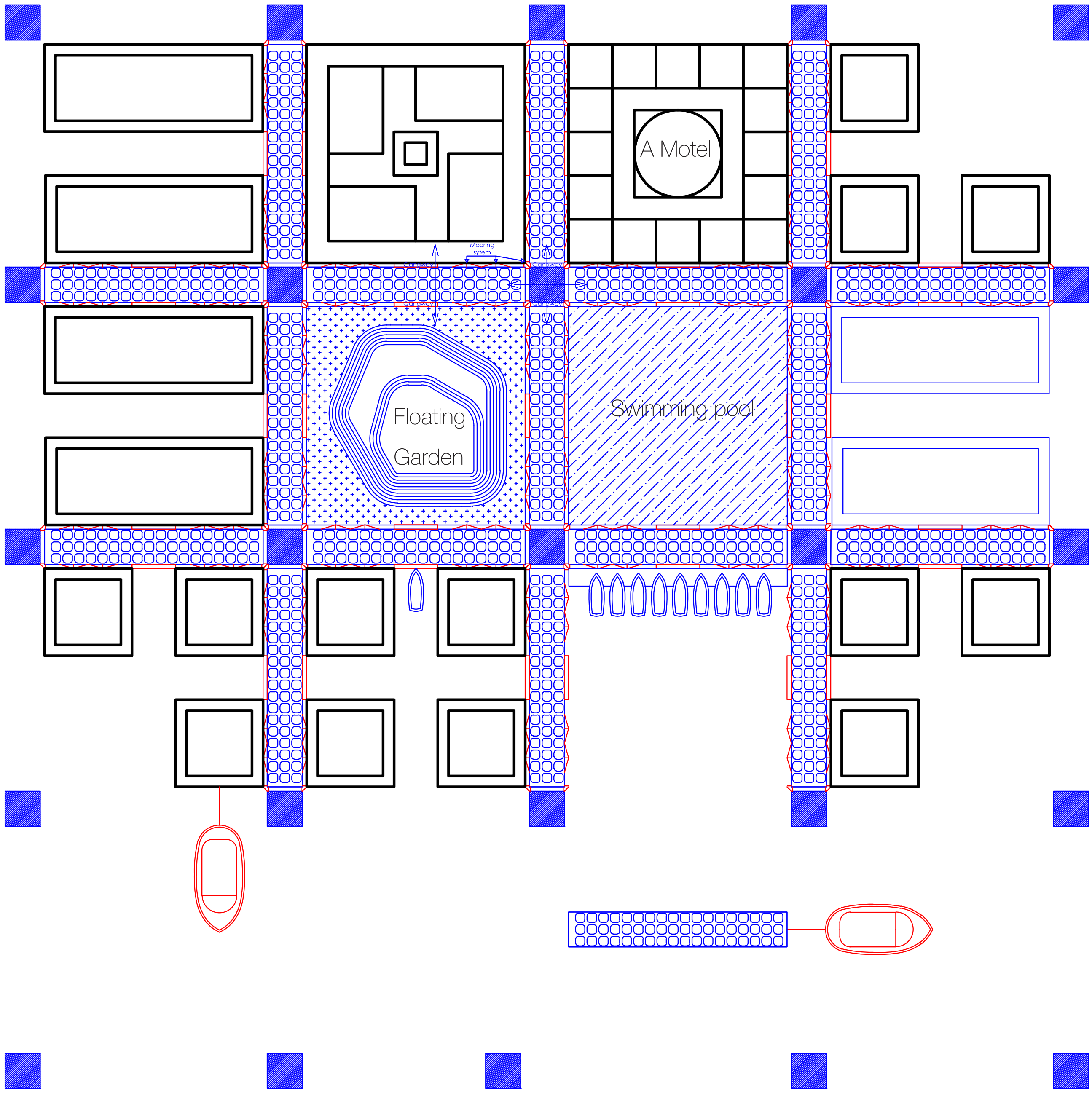


Figure 92: A layout showing the configuration of pedestrian bridges network.

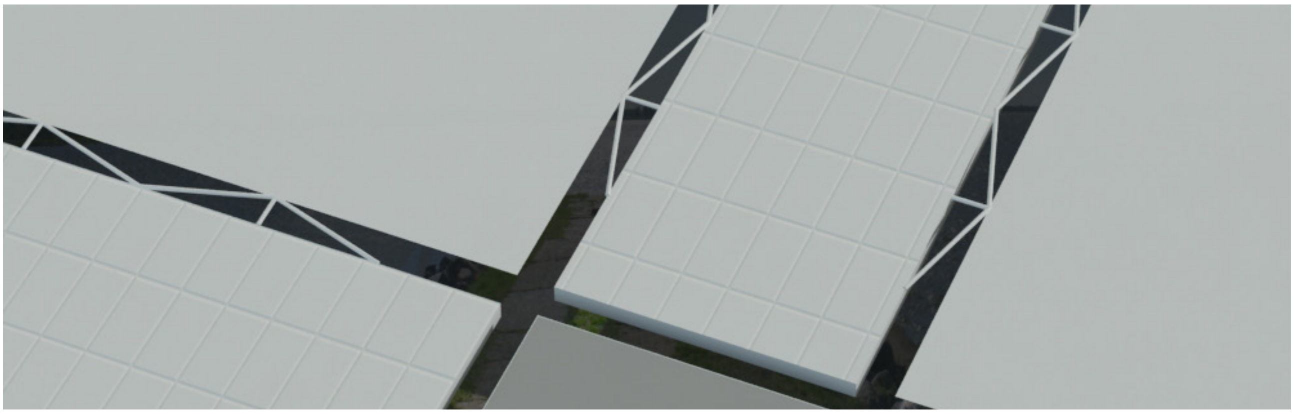


Figure 93: The mooring system technique used in the designed framework.

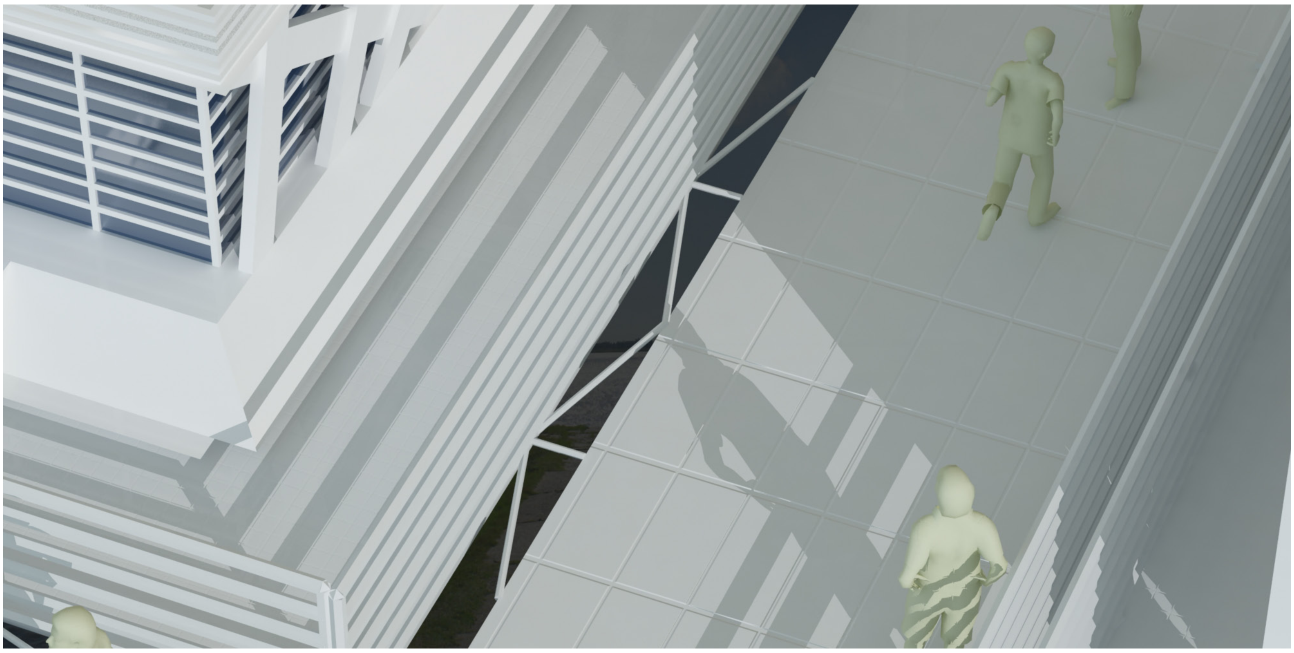


Figure 94: Handrail should exist in every floating unit for inhabitants safety.

Figure 95: Double hand railing between the bridges and units ensures more safety for pedestrians.

4.9 Urban components

A comparison between a satellite image of a neighborhood grid in New York city and the community grid showing similarities in the urban components in both pictures except for the usage of cars in the transient community, which were replaced with boats and water taxis.

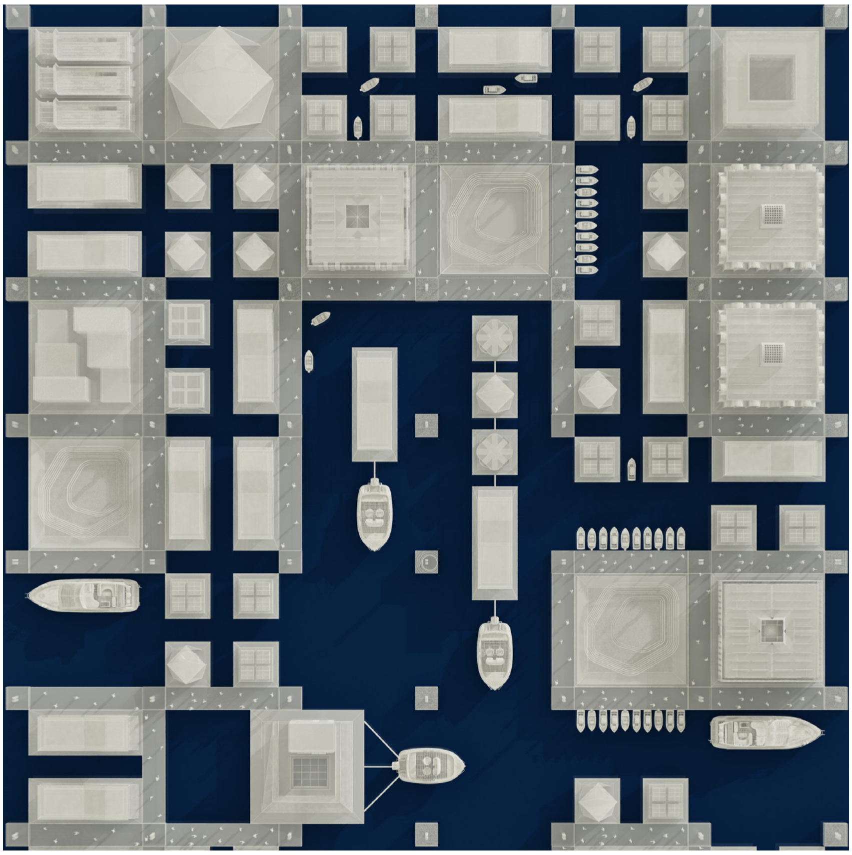


Figure 96: Comparison between the urban components of the transient community and a neighborhood grid in New York city.

4.10 Adaptation and flexibility

Adaptation, in this framework, can be described as the ability of specific components of the transient community to change in response to variety of factors. Adaptable architecture terminology has been used a lot in visionary architecture projects. However, in this thesis, adaptation is the main core of framework.

To achieve adaptation, flexibility of the components of the framework is essential. Flexibility can be categorized in three levels:

1- Flexibility in location.
Considering that the framework exist on water which cover 70% of the World and many cities on the world are coastal cities, the framework of design can be located next to any coastal city waterfront.

Locations can be chosen in respecting to the aesthetic image of the city, the existence of facilities and transportations hubs of the city.
Design can be adjusted according to the coast line topography of the city and the planned density of the transient community.

Although the framework is flexible to be applied to different locations. Locating a transient community can be challenging in some coastal cities due to coastal hazards. In such cases, some precautions can be taken to safe the community from possible hazards such as locating rock barriers to control water waves and tides.

2- Flexibility in spatial configurations.
The flexibility of water allows units to be easy tugged to different location within the community. This allow generating variety of neighborhood clusters. Spatial configurations can be determined based on many issues such as community density or weather or inhabitants decisions.
Spatial configuration is described in detail in this chapter.

3- Flexibility in design of floating units:
As previously mentioned the framework provides flexible unit design through 3 different floating plots that can fits to different inhabitants need, the architectural design of prototypes is fertile field, in this thesis, some prototypes are shown as guidelines.

4.11 Spatial configurations

Taking a closer look, floating units are working as Lego pieces. There are variety of forms that can be generated for the transient community. The form of the community is generated by inhabitants and the planning system controlling the community. The planning system can set a number of rules or guidelines to control the generating process. However applying these rules to the floating units that keep movement is challenging. Therefore, a computational mathematical theory called Cellular automata can be used to generate forms under some rules.

Cellular automata is the computational method which can simulate the process of growth by describing complex system by simple individual following simple rules. This offers an interesting and rich platform from which to develop possible architectural patterns. Cellular automata can be defined as a lattice of dynamic cells. A neighborhood relation is defined over this lattice, indicating for each cell which cells are considered to be its neighbors during state updates. With each change in the configuration, each cells updates its state using a transition rule.

There are two types of neighborhood. The first is Van Neumann neighborhood where neighbors are the cells directly above, below, to the left and to the right of the cells. The second type is Moore neighborhood where eight neighbors surround the cell as shown on Fig (97) and Fig (98).

The hybrid self-organization system can be generated following some rules. In the framework introduced in this thesis, rules or planning regulations can be defined for the community to organize the process of form generating. These rules can be set individuality or combined together such as:

- Every floating unit should have one direct access to water and one access to the floating bridges.
- Pedestrian bridges should provide a continuous, uninterrupted deck surface for pedestrians.
- An internal watercourse in the community, allowing the boats to roam freely.
- Every floating units should have two access to water and one neighbor and one connection to pedestrian bridges.
- Every 8 floating units should have an access to a floating garden.

Different set of rules can be applied together in the same community to generate patterns with different densities.

Through this framework the top-down plans by the government and the bottom-up plans by inhabitants previously discussed in chapter two can be integrated

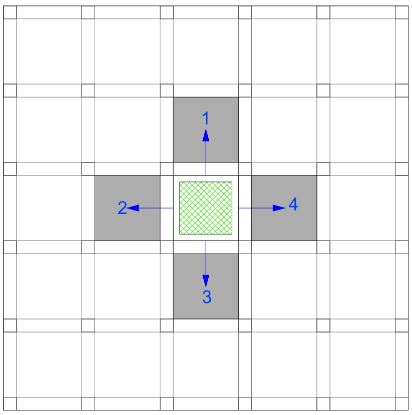


Figure 97: Van Neumann neighborhood

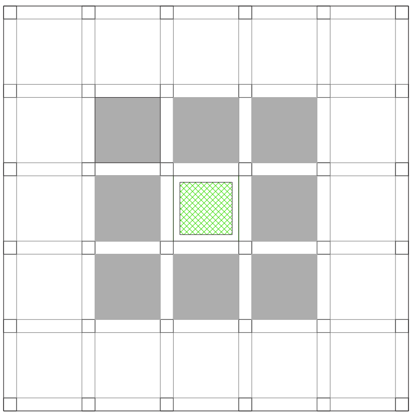


Figure 98: Moore neighborhood

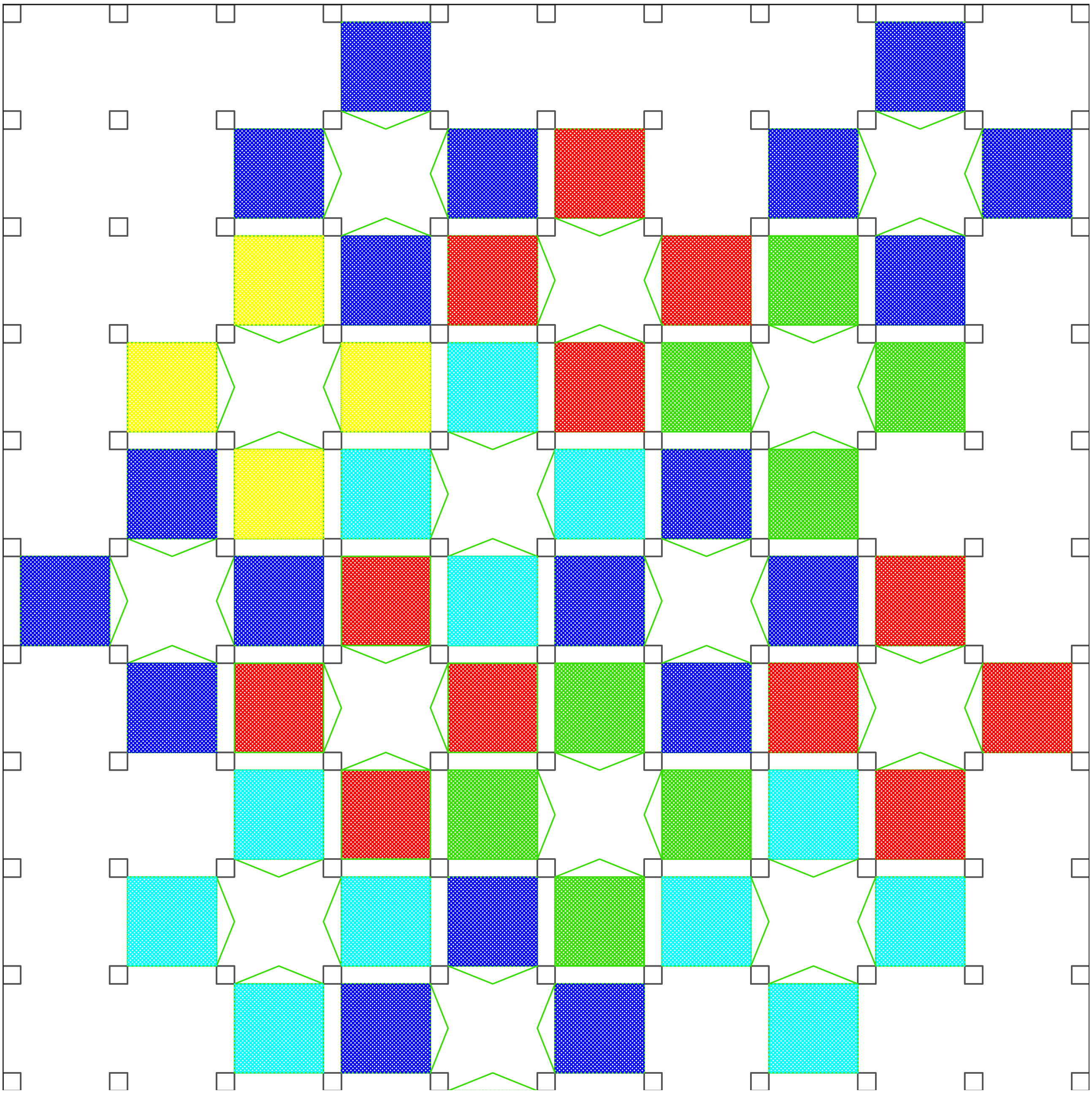


Figure 99: Each 4 floating units are clustered around a swimming pool. Every unit have 3 neighbors

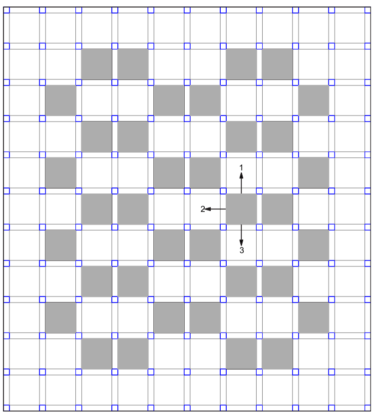


Figure 100: 1 Neighbor

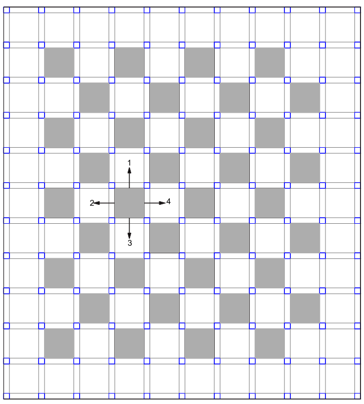


Figure 101: No neighbors

In Figure 99, 100,101: Empty frames between the units can be used as floating gardens or swimming pools. The grids ensures a continuous surface of pedestrian bridges. Units can not be accessed by boats.

In this framework, transient community is clustered around three permanent islands connected directly to the waterfront and can be accessed from the main city land and the floating community. The islands contain a cultural center, three adaptable 'work-unit' towers and park/ commercial area. These islands perform as an intermediate of interaction between many cultures. City growth is flexible as it can accommodates to growing population to a certain limit that can be determined by location of facilities and walking distances to maintain the quality of life for inhabitants. However facilities can be accessed by boats and water taxis that roam around the floating units. Additional transient communities can be added to different locations of the city.

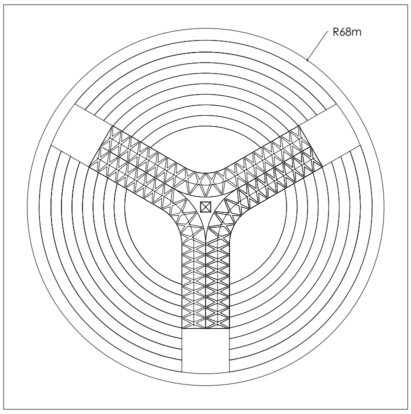


Figure 102: Park/ commercial area

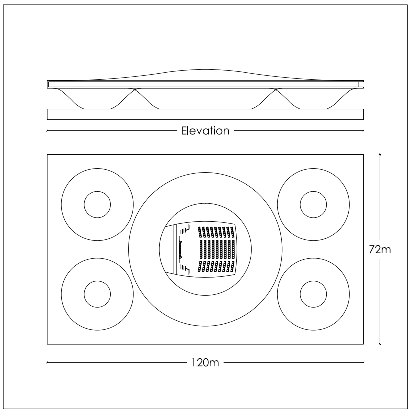


Figure 103: Cultural center

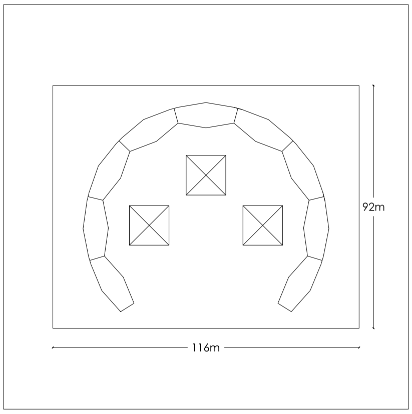


Figure 104: three 'work-unit' towers

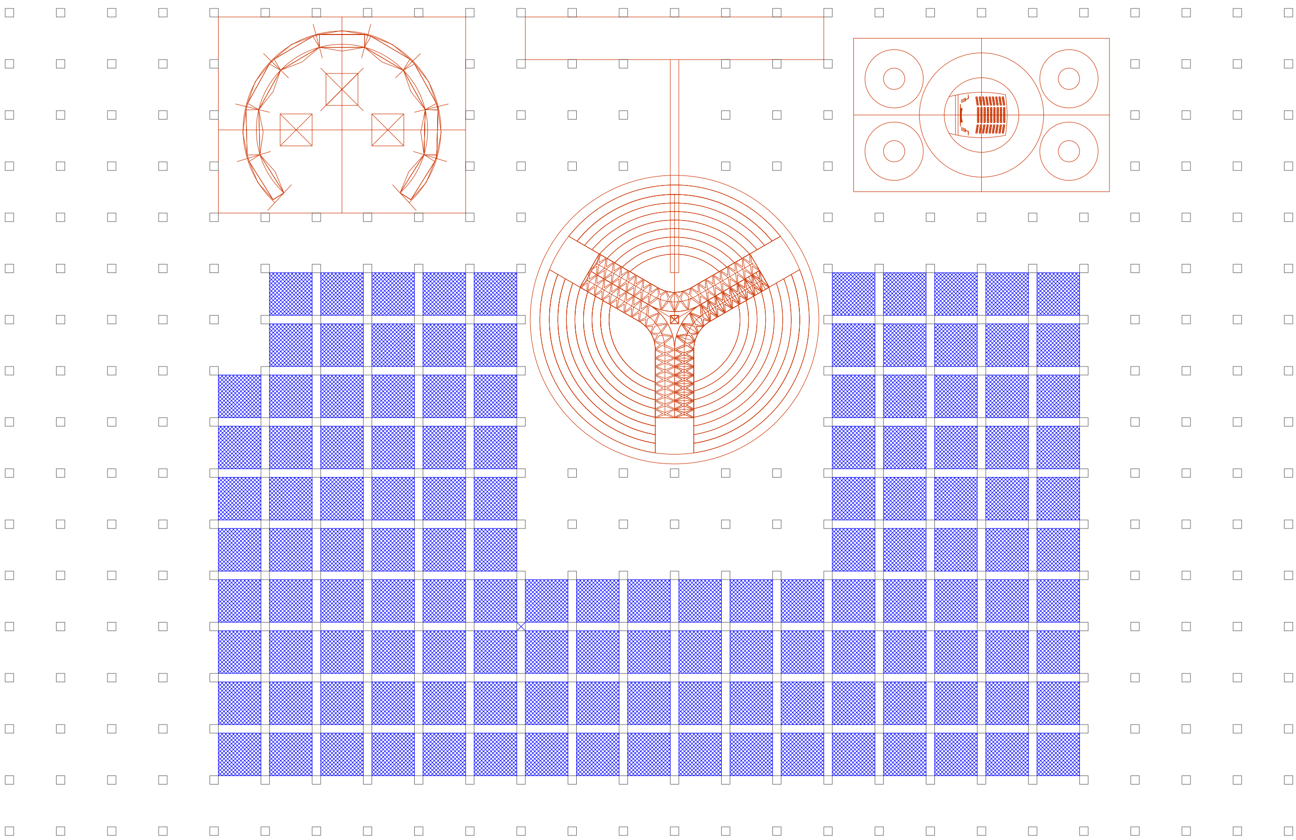


Figure 105: spatial configuration for higher density, convenient in summer to control the microclimate. some units can be floating gardens.

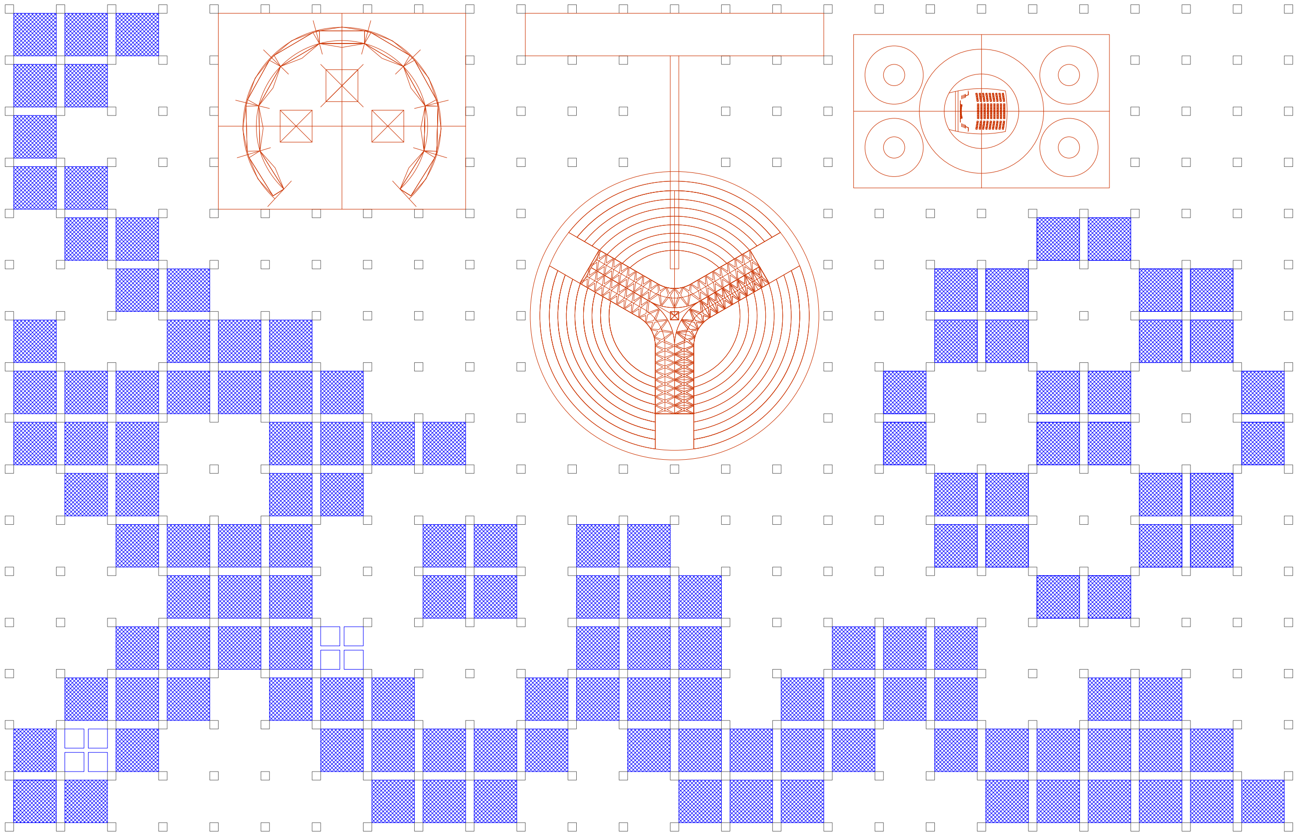


Figure 106: Integration of different patterns surrounding facilities.

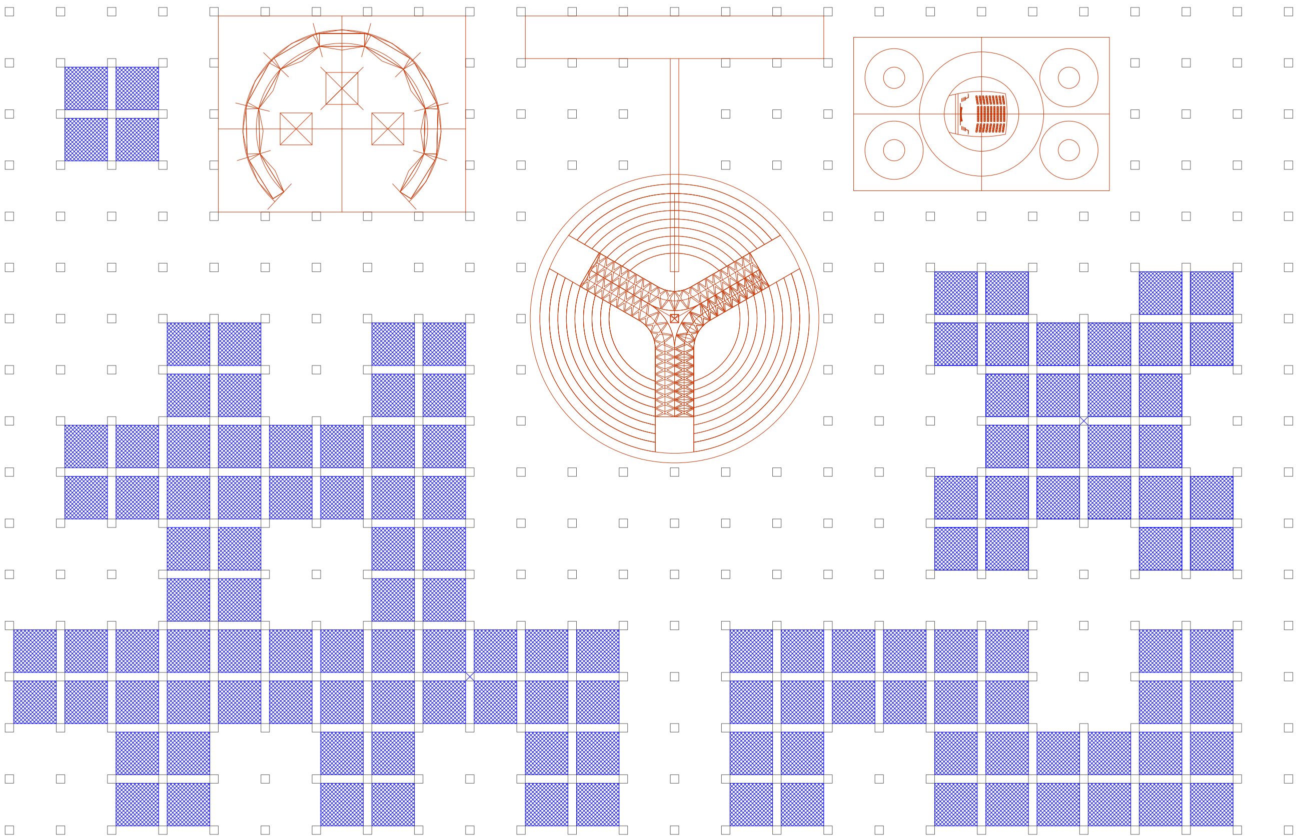


Figure 107: Units in this configuration can be easy tugged to different locations

Some urban cluster can be inspired from the existing urban forms on land such as the urban clusters such as the suburban in Arizona in Fig 108.

Figure 108: suburban in Arizona, USA.

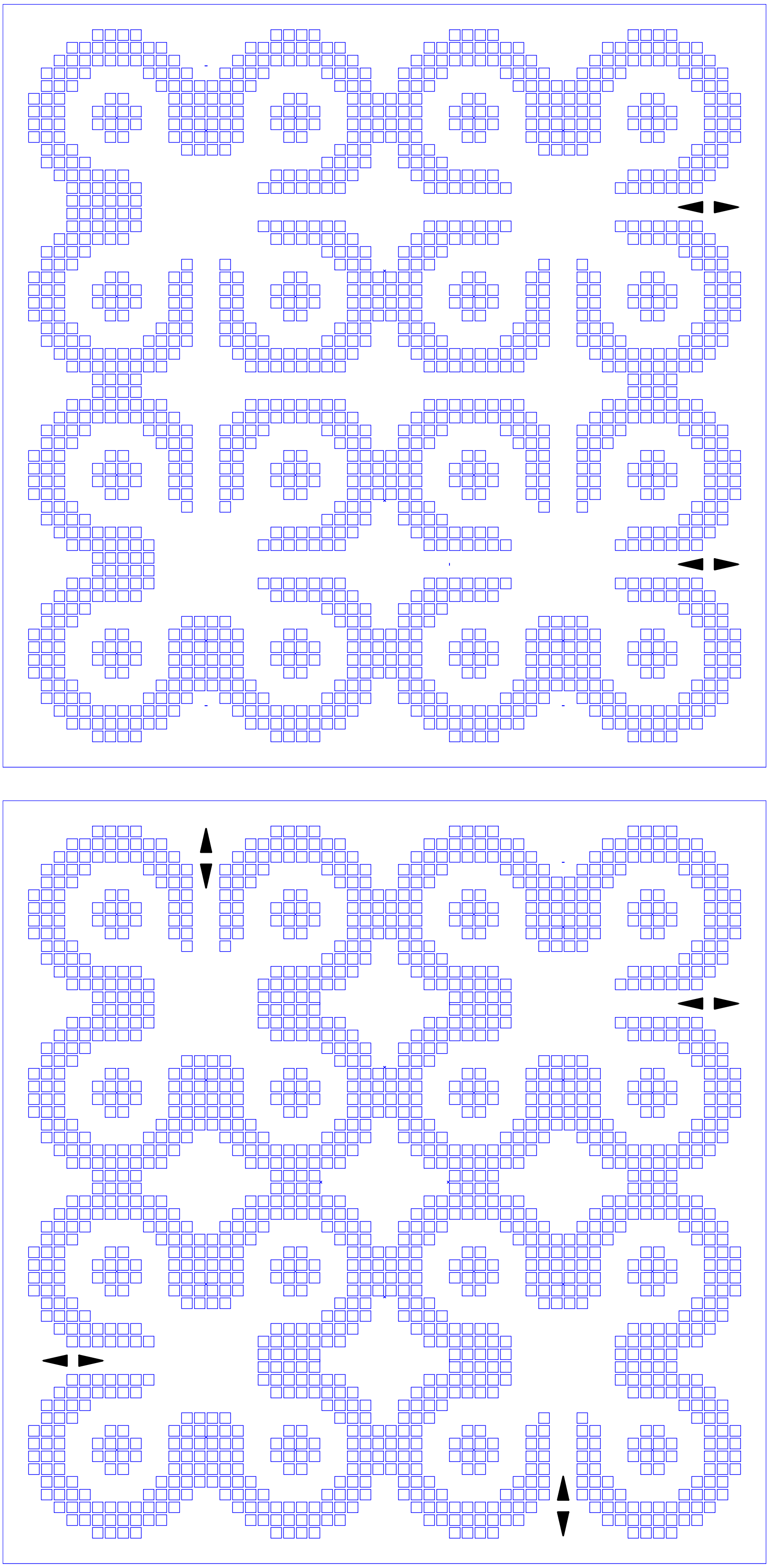


Figure 109: Two different patterns inspired from suburban in Arizona

4.12 Controlling dynamic configuration process

Taken into consideration the three levels of flexibility occurring in the design and the ability of floating units to change their location within the community, organizing the movement of units should be controlled by a system. The system allows users to choose their locations in the framework grid based on the stay intervals of these units in the framework. Users can use a mobile application or a program to organize the process of movement and the day of arrival and departure in the system. Through this, the continuous movement of units can be organized and units can be tugged easily without causing distribution to other units.

The system can organize the units based on different parameters such as:
Units with long stay can be placed at the core of the community, while units with short stay are being placed at the outskirts of the community. Larger floating units, which accommodate higher number of inhabitants, can be placed at the core of the system.

4.13 Movement

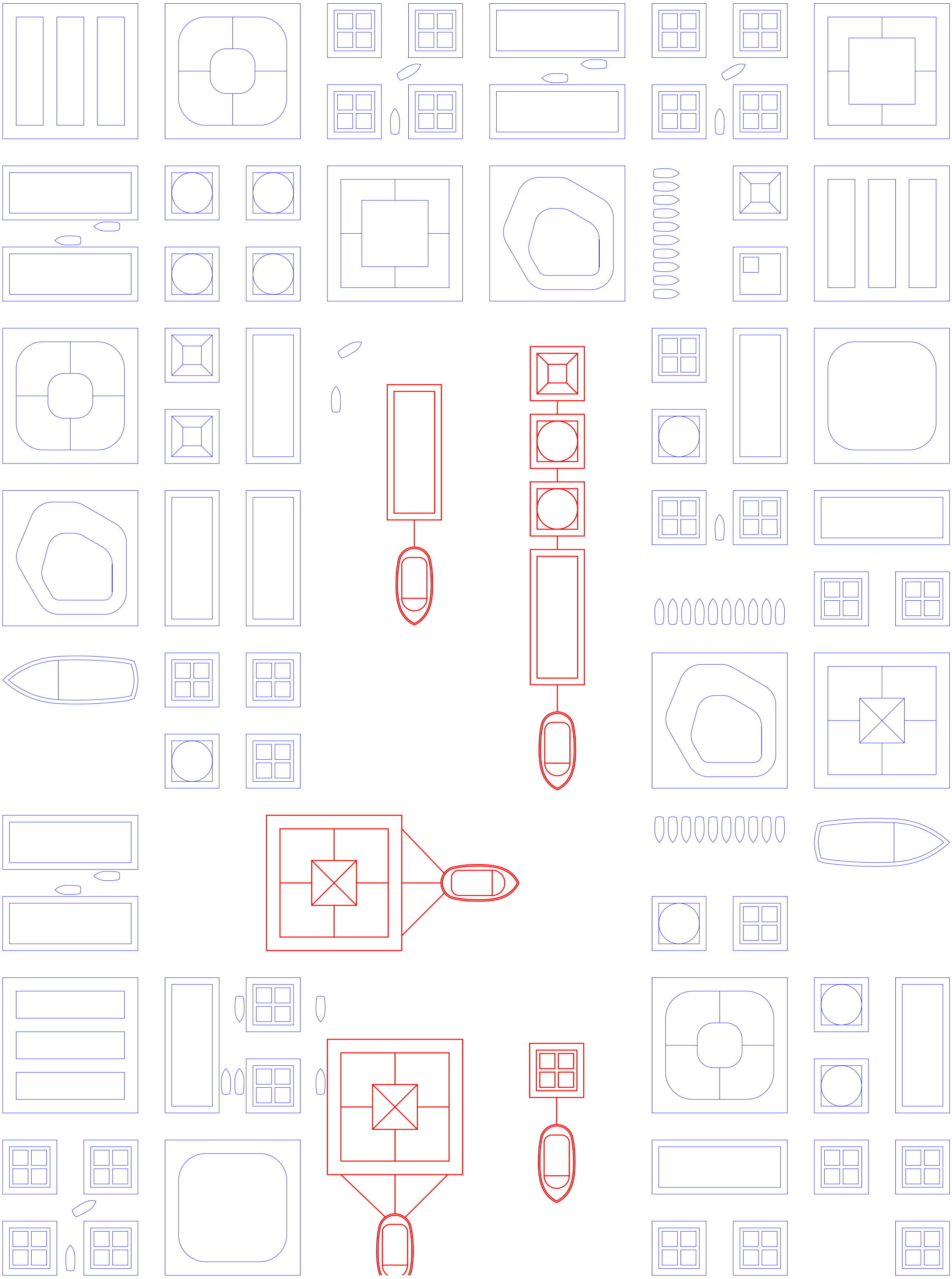


Figure 110: A diagram showing the tugging process in the transient community.

Units can be shipped to different far locations using big ship such as MV Blue Marlin which is used for shipping ships.

Water taxis and private water jets can be used for transportation in the transient community.

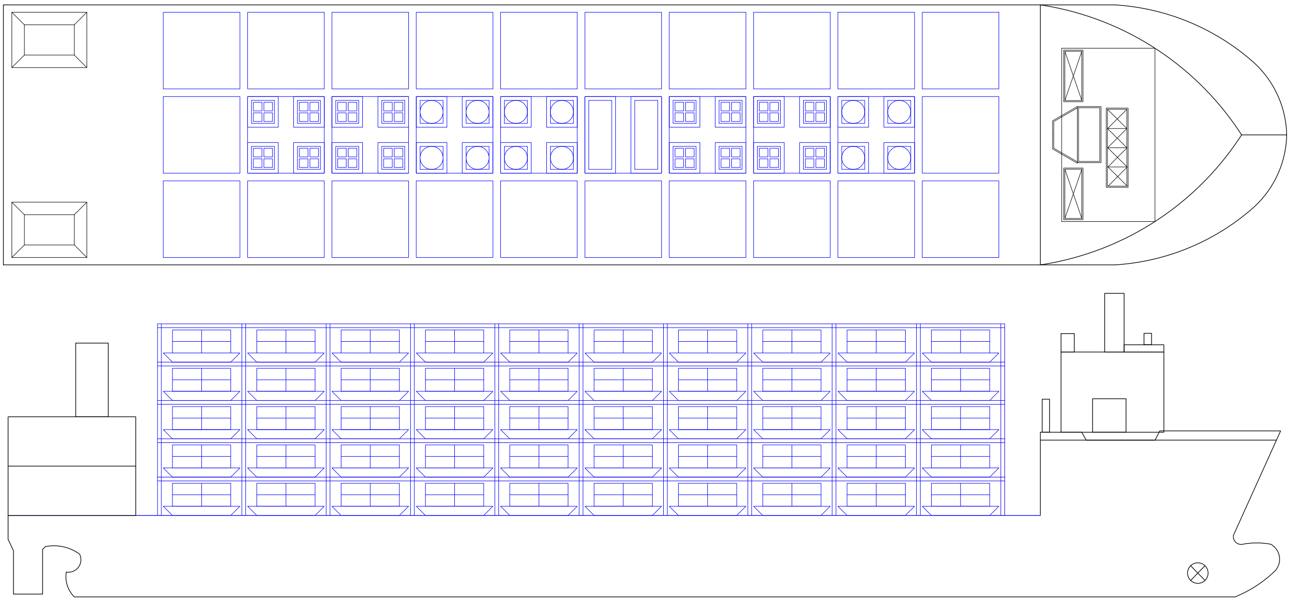


Figure 111: MV blue Marlin shipping a group of stacked floating units

Figure 112: Quadrofoil watercraft.

Figure 113: Water Taxi

Figure 114: Semi- submersible MV blue Marlin.

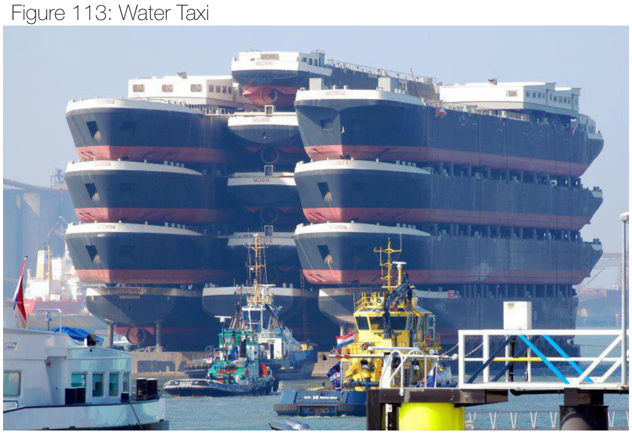


Figure 115: Blue Marlin shipping big ships

4.14 Intervention on Architectural scale.

The prototypes shown in this section are abstract prototypes clarifying spaces and ratios of the housing units. Units can be customized to inhabitants needs allowing great variety in the final outcome.

Prototype 1: Motel design of 400 m^2 (20m*20m)

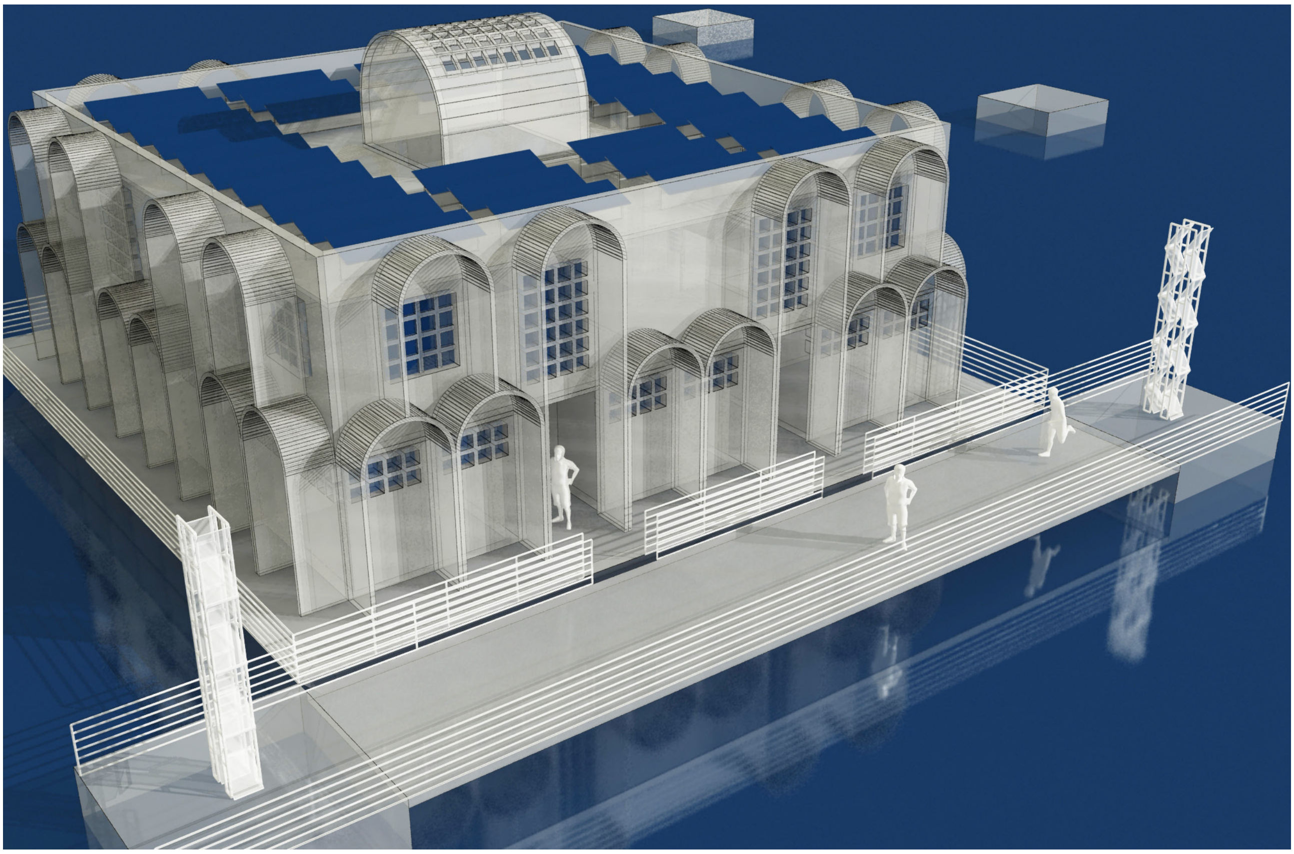


Figure 116: prototype 1 preceptive

Figure 117: prototype 1 elevation

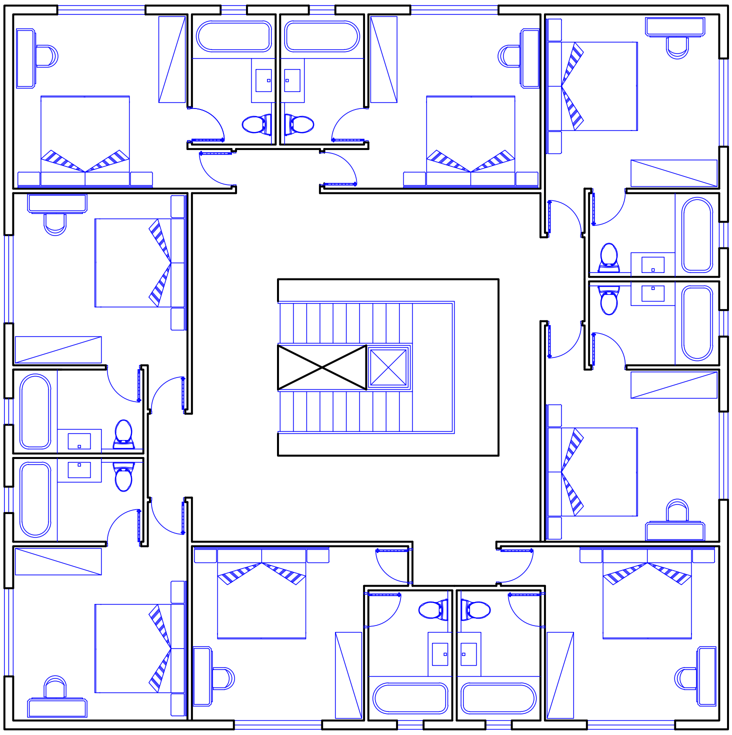


Figure 118: first floor plan with 8 motel rooms

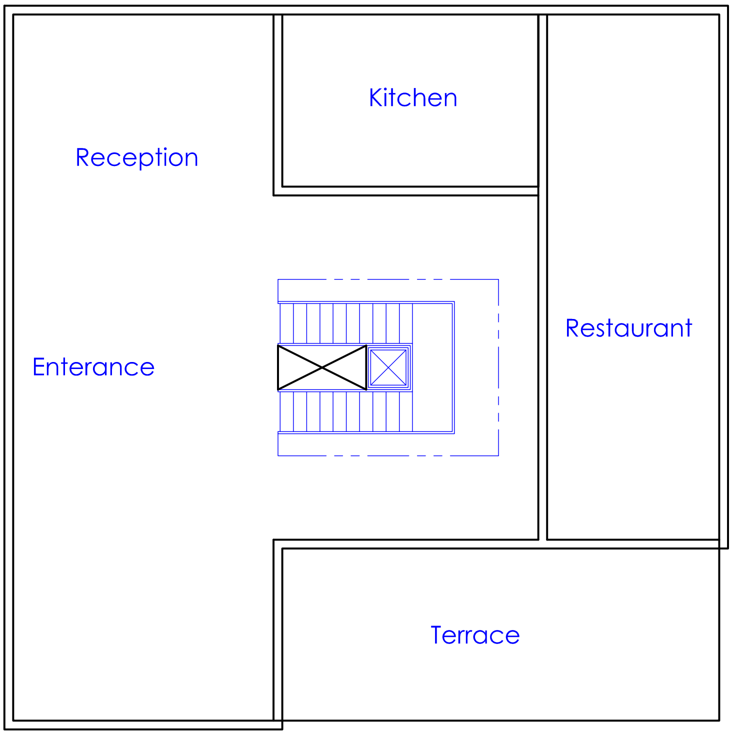


Figure 119: ground floor plan

Prototype 2: Two apartment units of 400 m² (20m*20m)

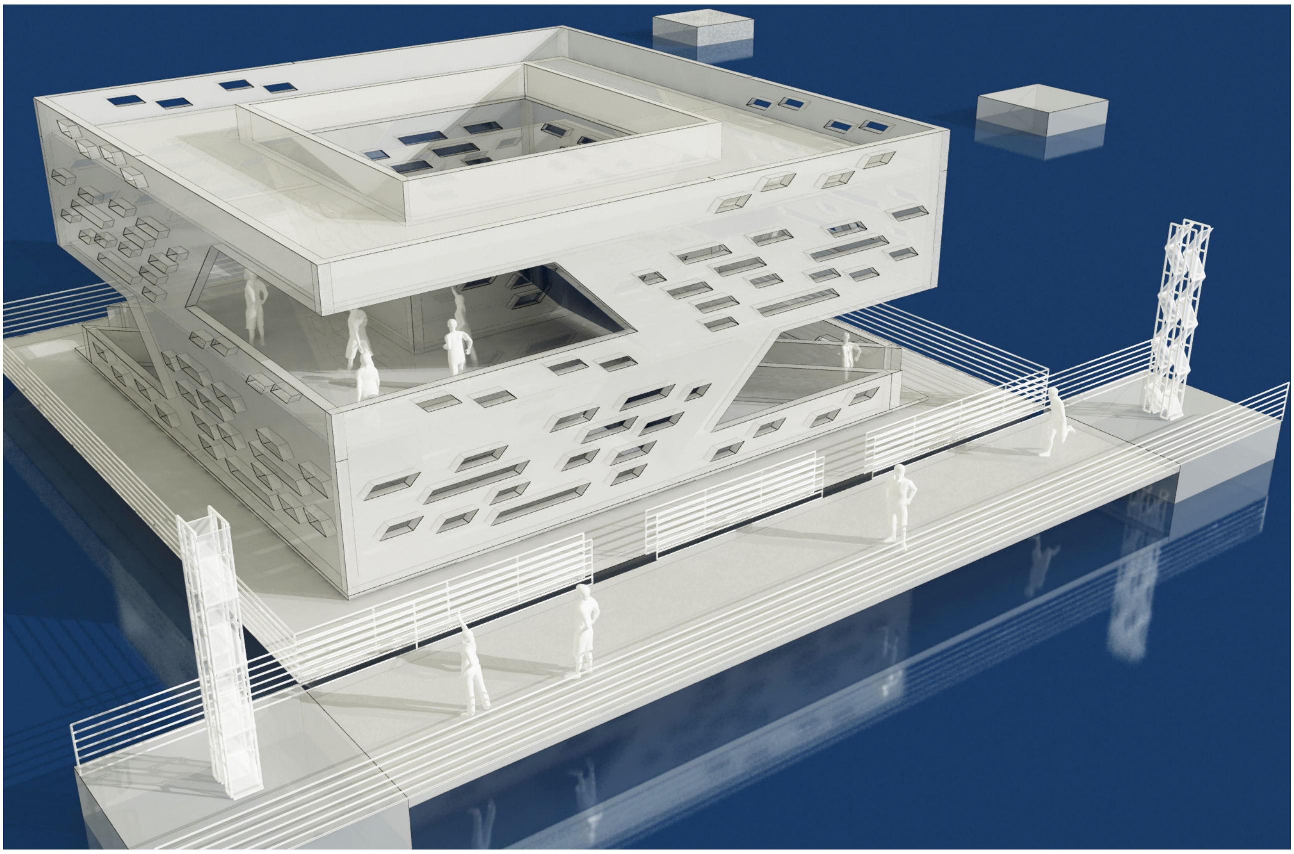


Figure 120: prototype 2 preceptive

Figure 121: prototype 2 elevation

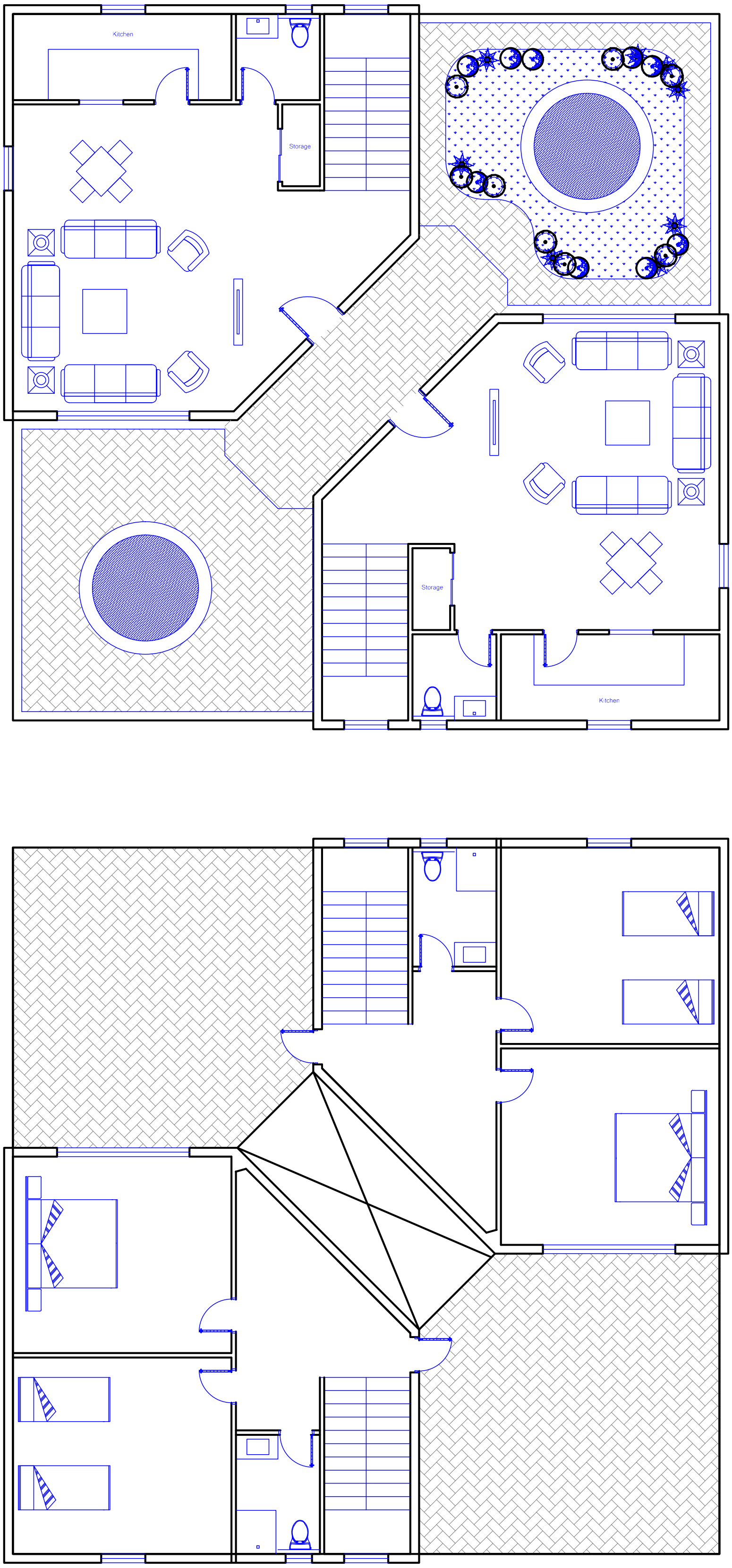


Figure 122: first floor plan with two apartment units with a garden (top), and ground floor plan with terraces.

Prototype 3: Floating of 160 m^2 (20m*8m)

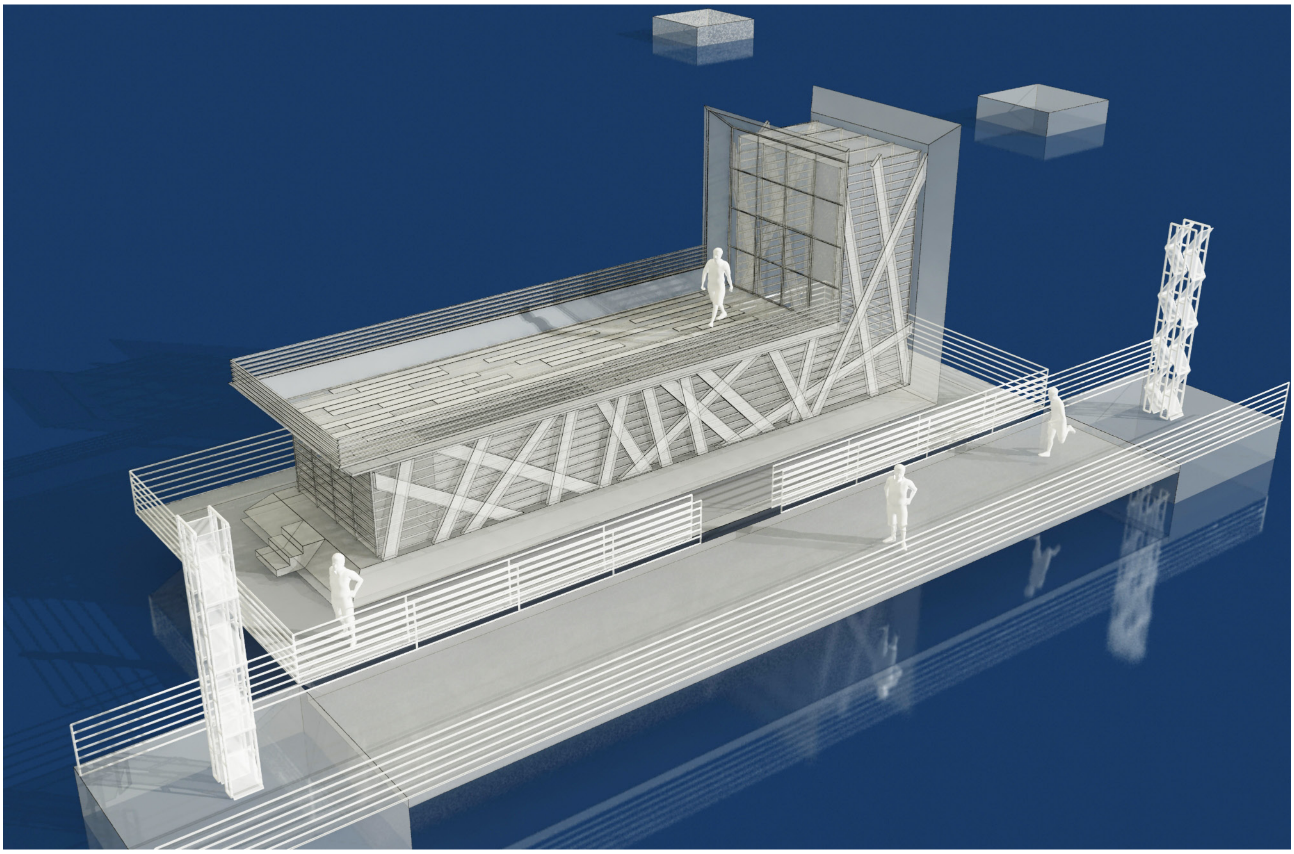


Figure 123: Prototype 3 preceptive .

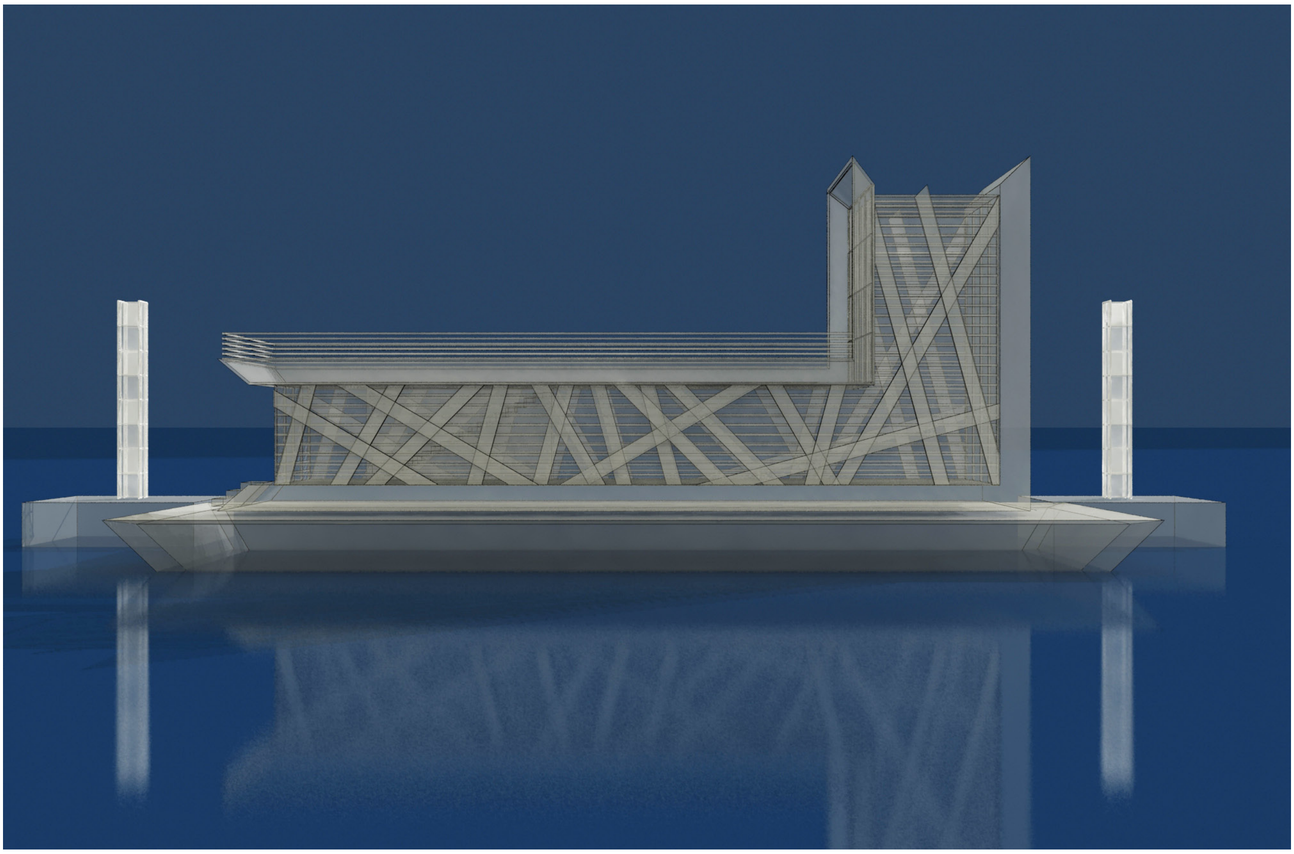


Figure 124: prototype 3 elevation.

Prototype 4: Floating of 64 m^2 (8m*8m)

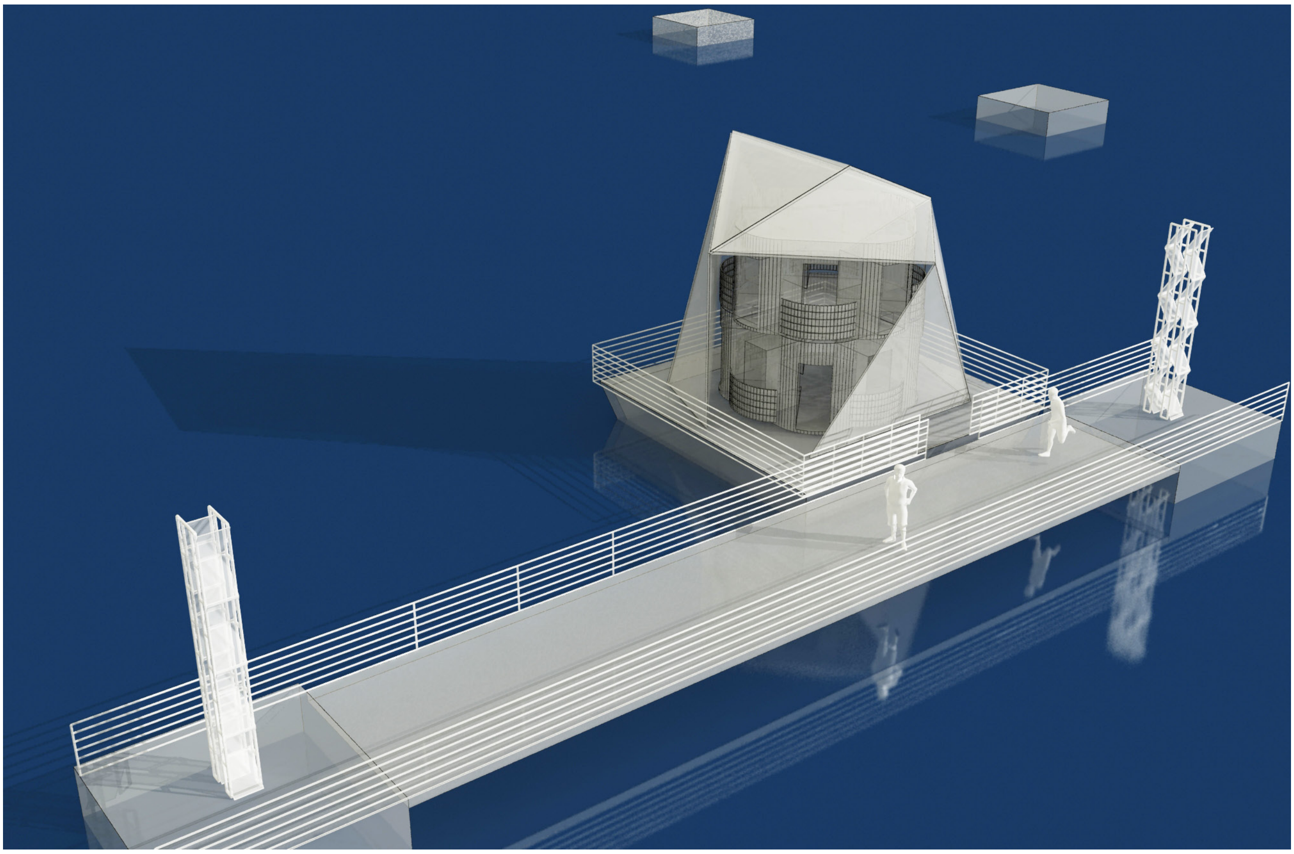
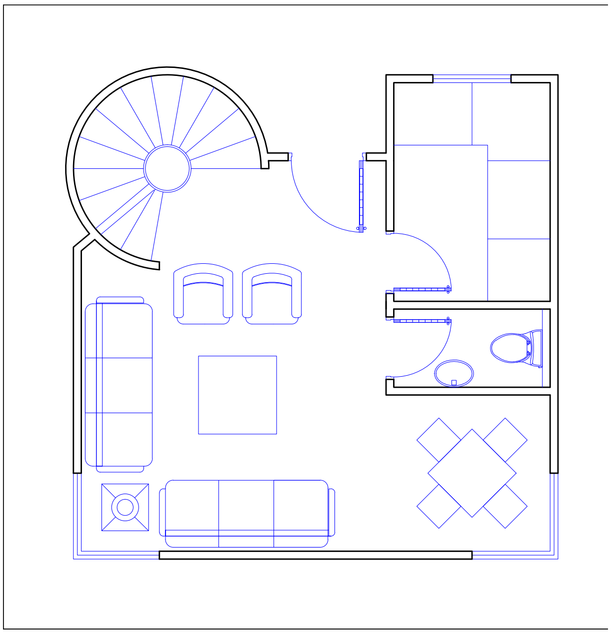


Figure 125: Prototype 4 prespective



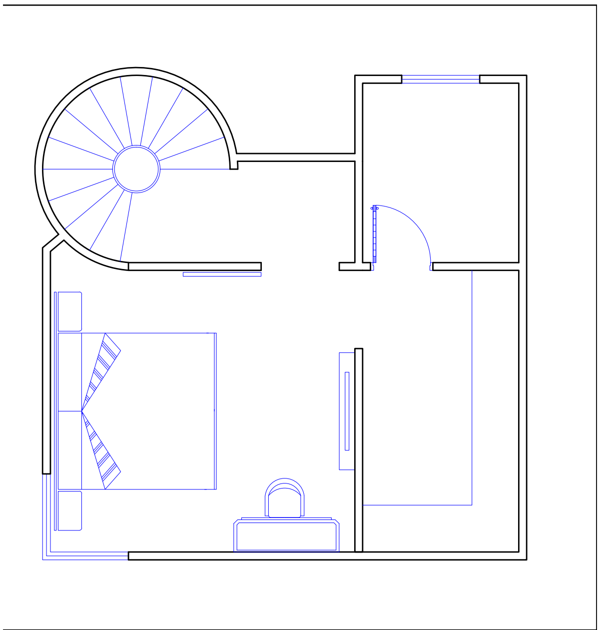


Figure 126: ground floor plan.

Figure 127: first floor plan

4.15 Cluster forms

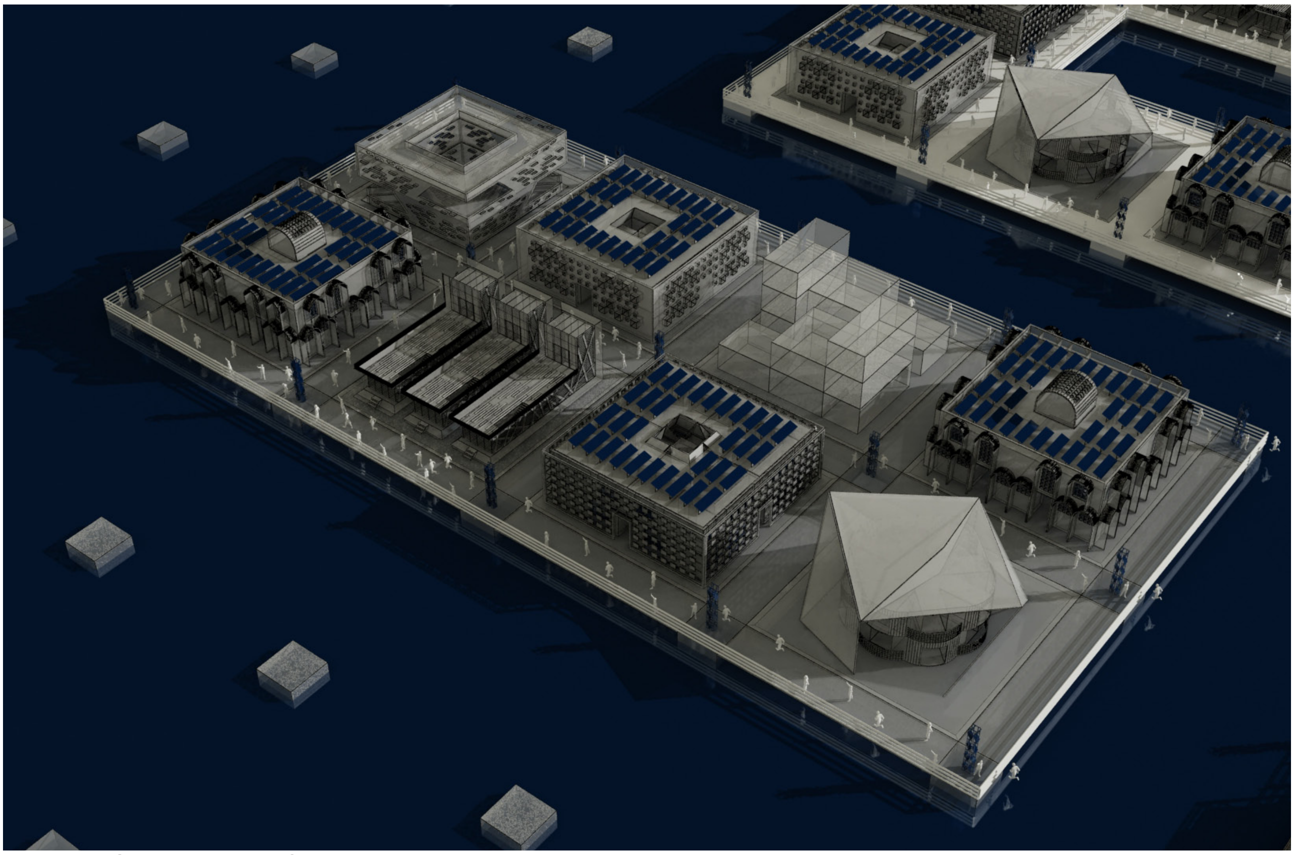


Fig 128: Cluster 1 The “ Grid”

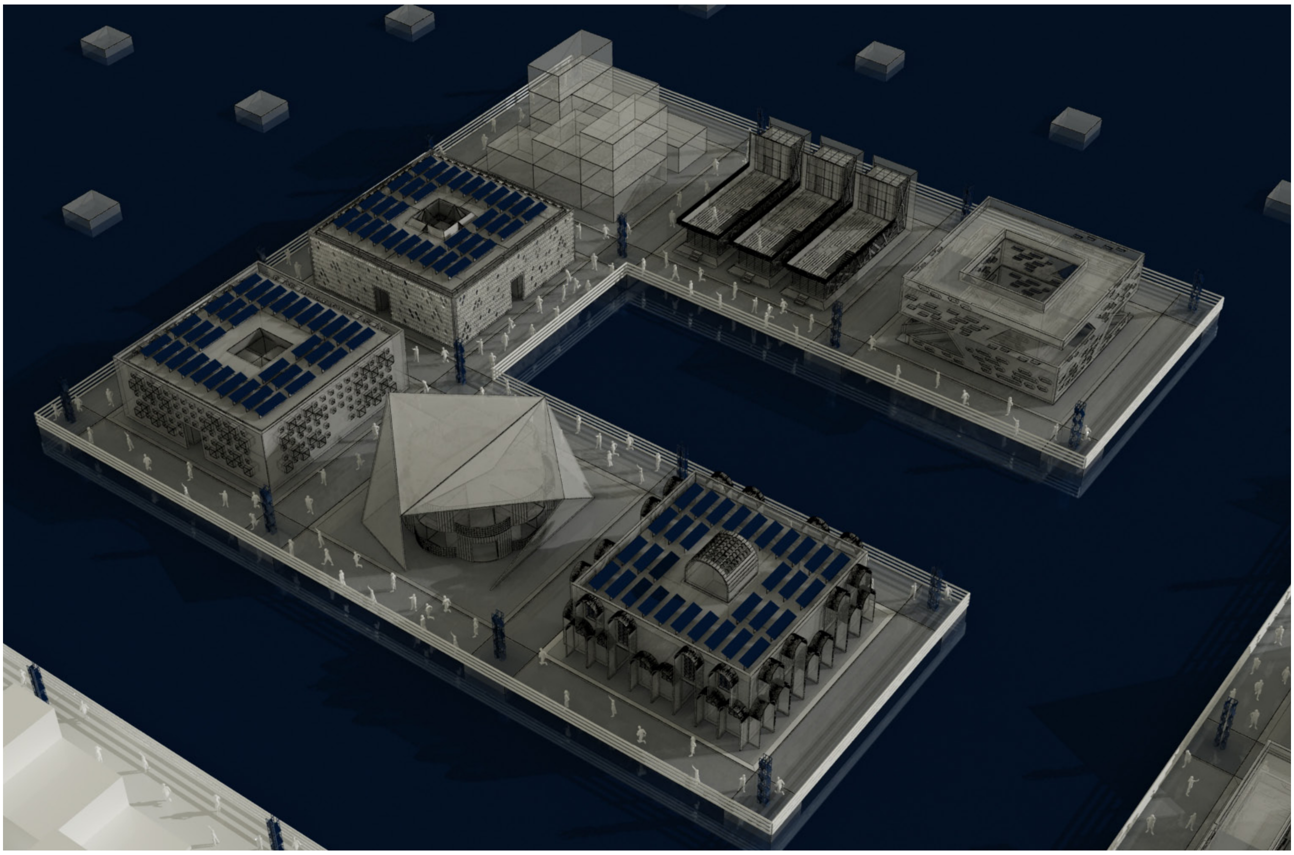


Fig 129: Cluster 2 The “ U” shape

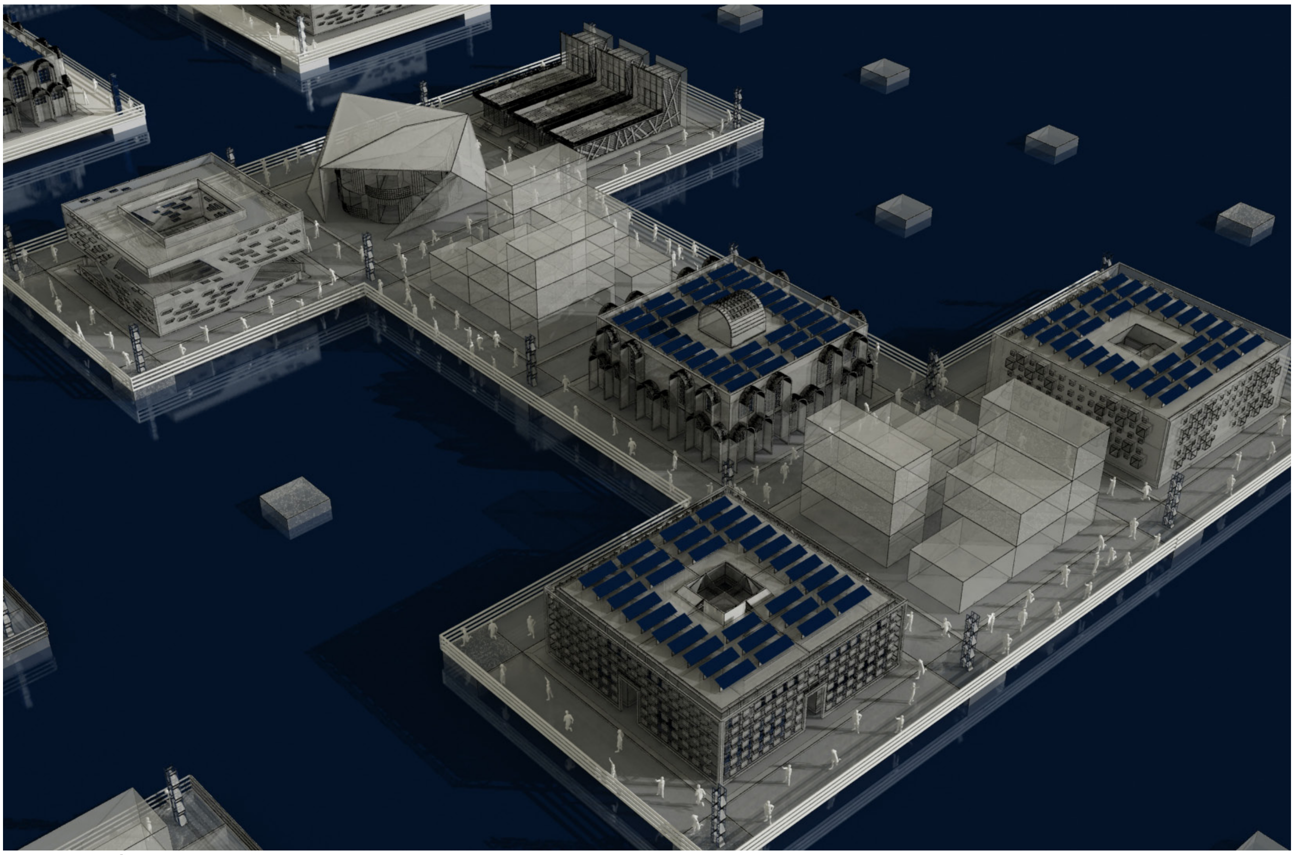


Fig 130: Cluster 3: The " I" shape

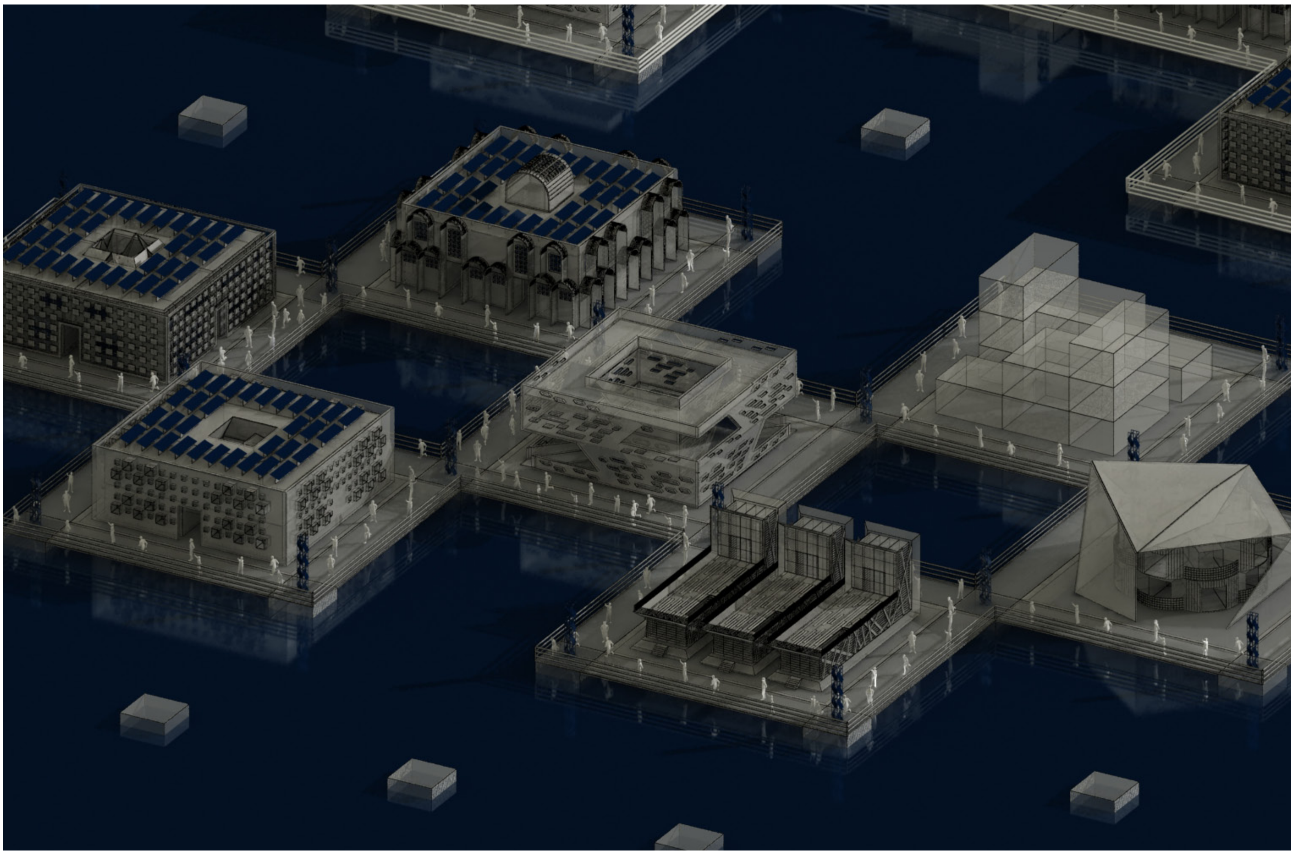


Fig 131: The " chess board" shape

4.16 Street Microclimate analysis

The floating units in the framework are two story height, around 6 m height. These dimensions are convenient for daily shading and controlling microclimate..

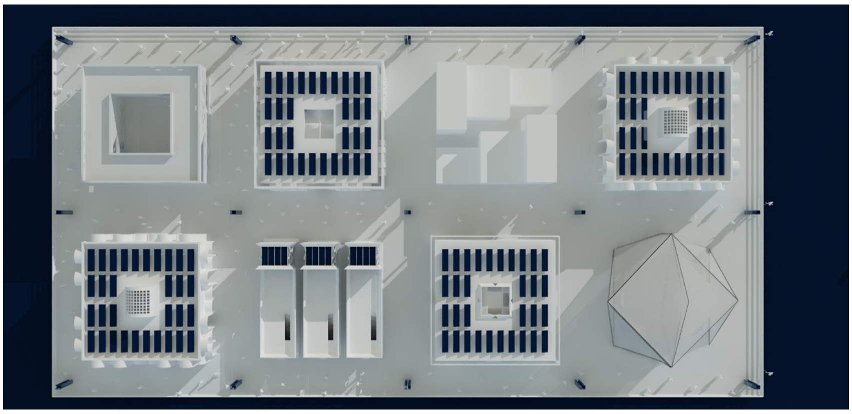


Fig 132: Grid of 8 floating units

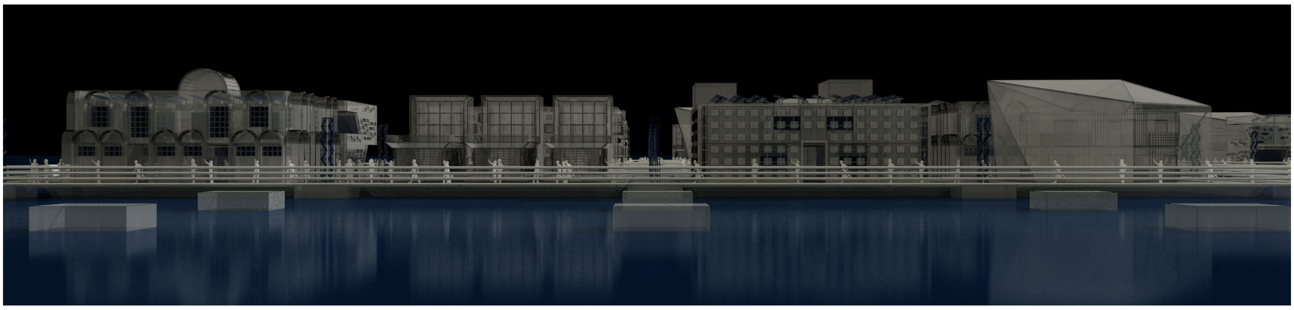


Fig 133: Elevation of floating units

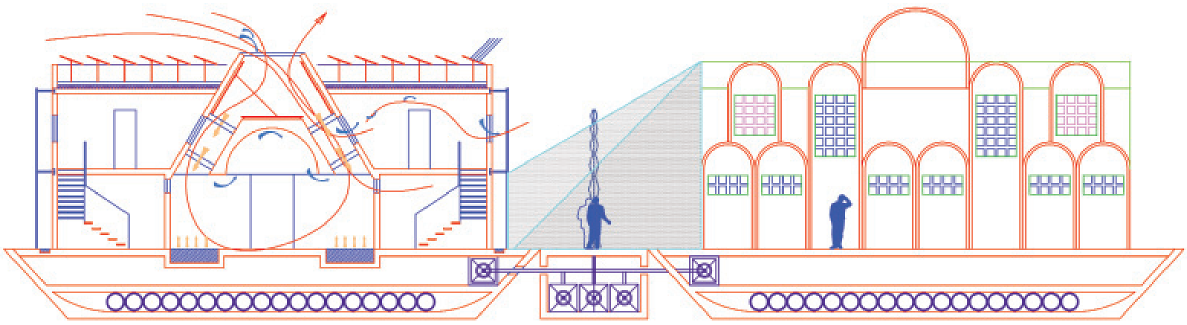


Fig 134: section showing shading between two floating units

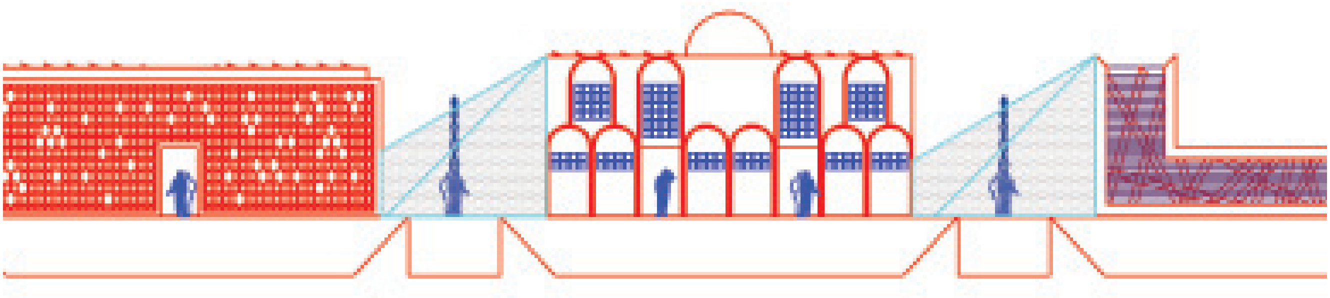


Fig 135: Section showing shading between a line of floating units

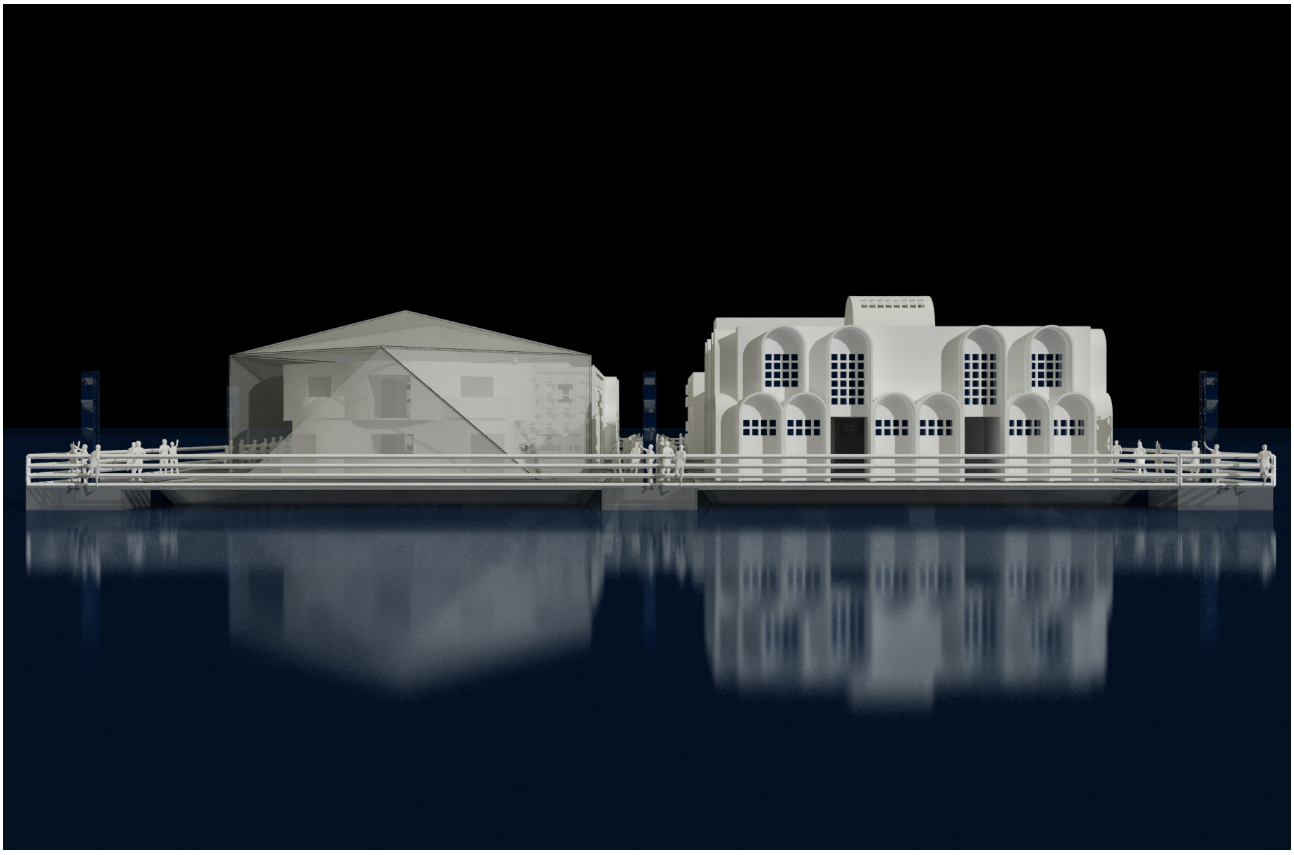


Fig 136: rendered elevation of 2 floating units

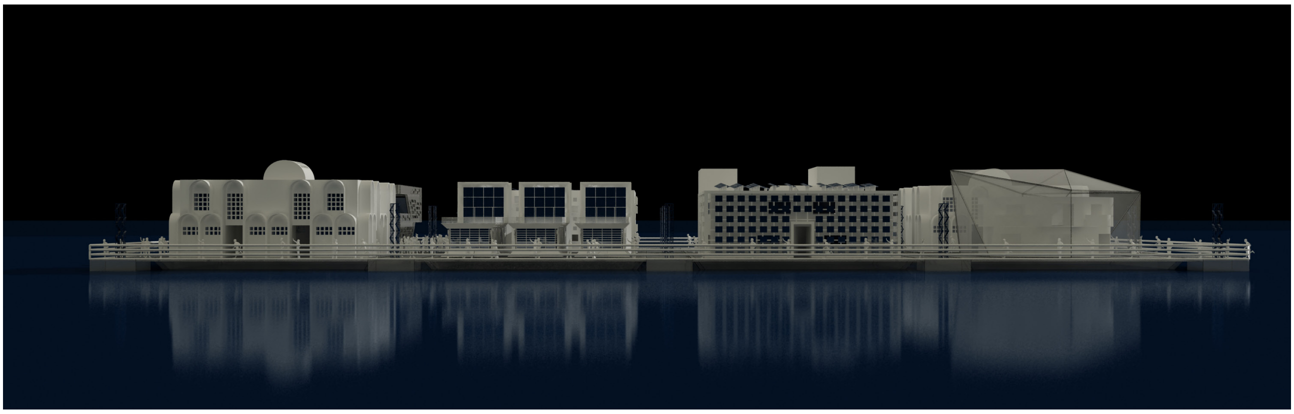
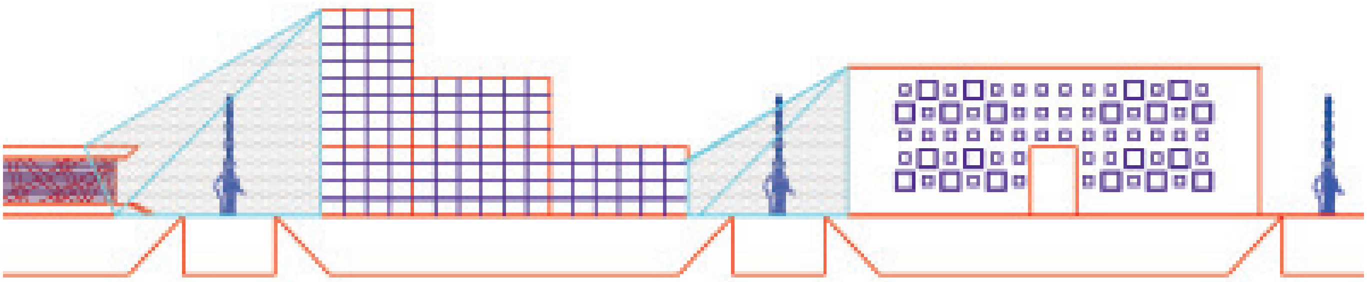
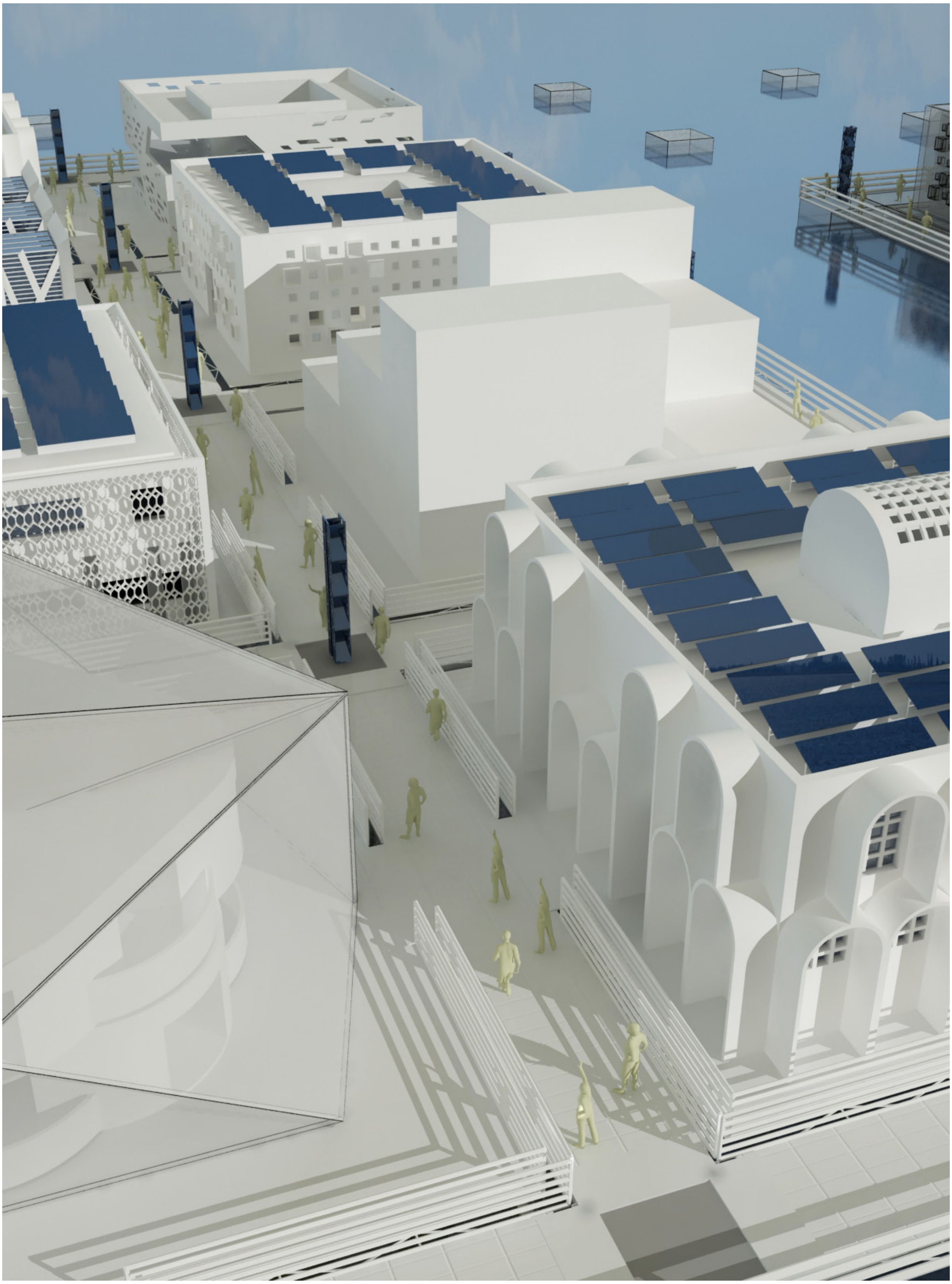
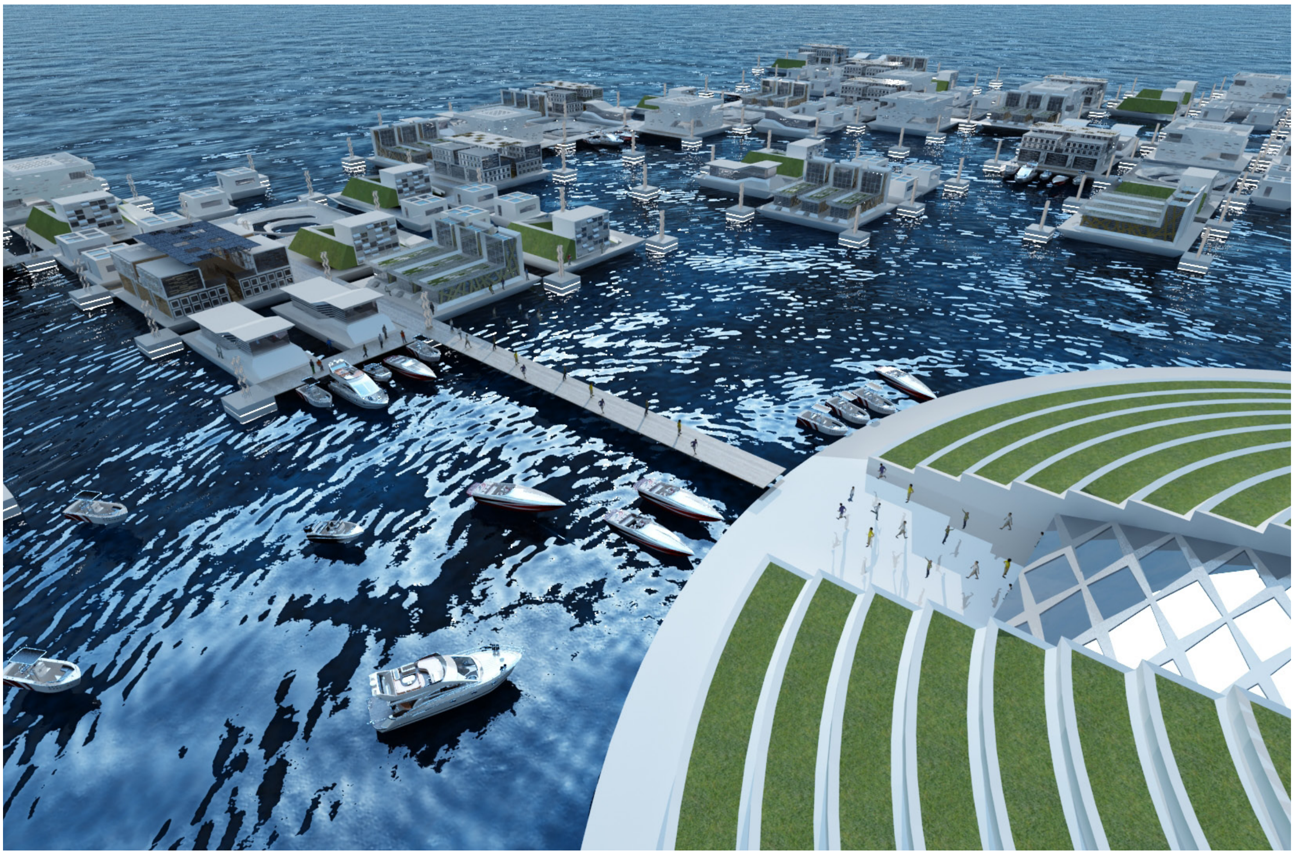


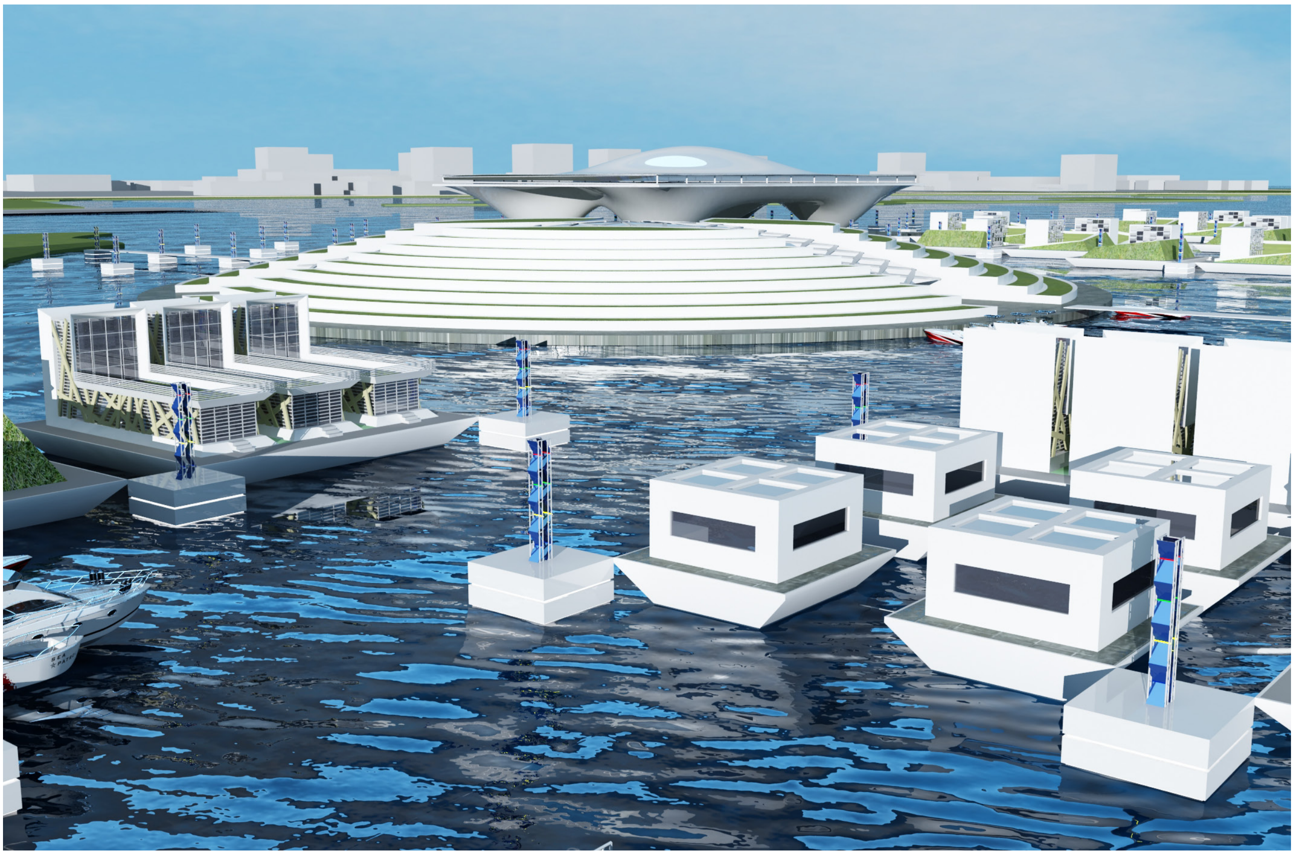
Fig 137: rendered elevation for a set of floating units

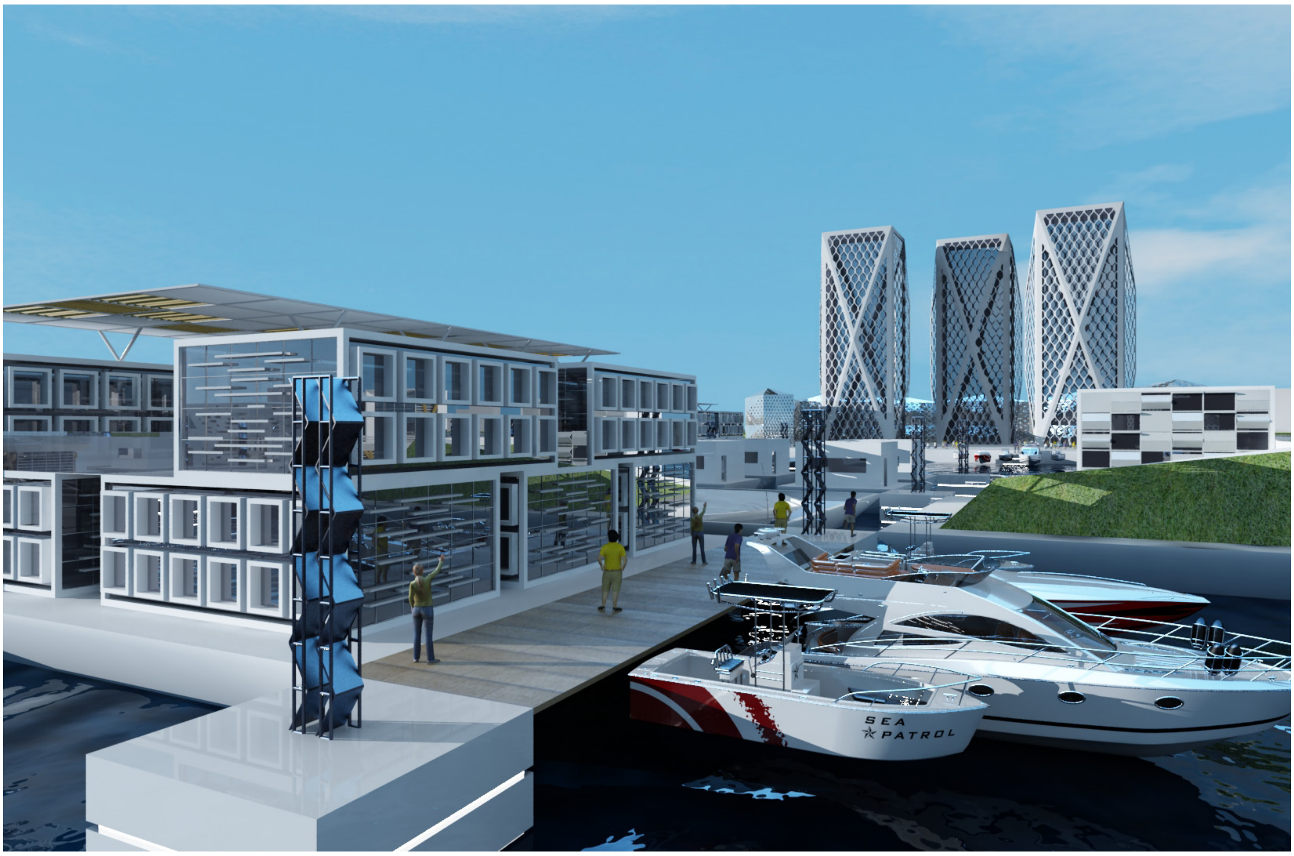


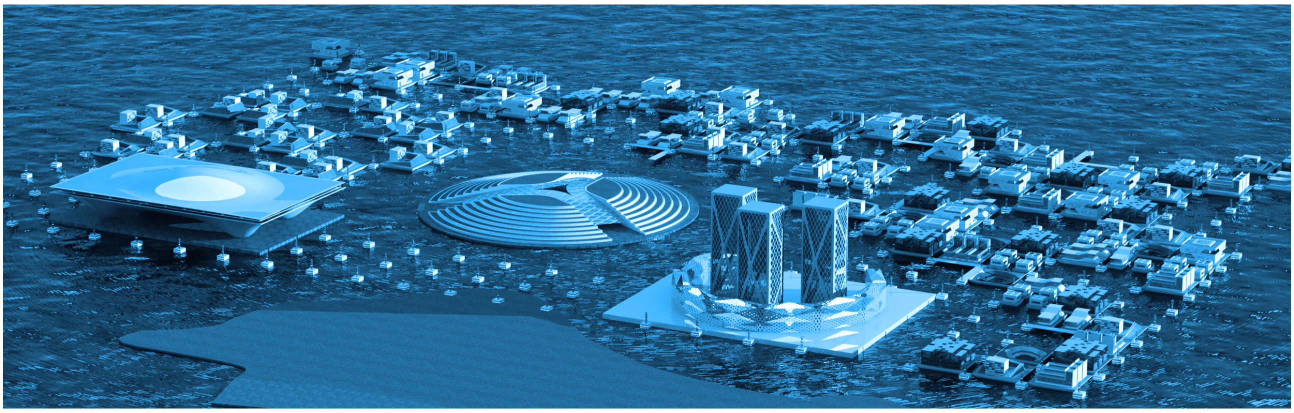
4.17 visualization

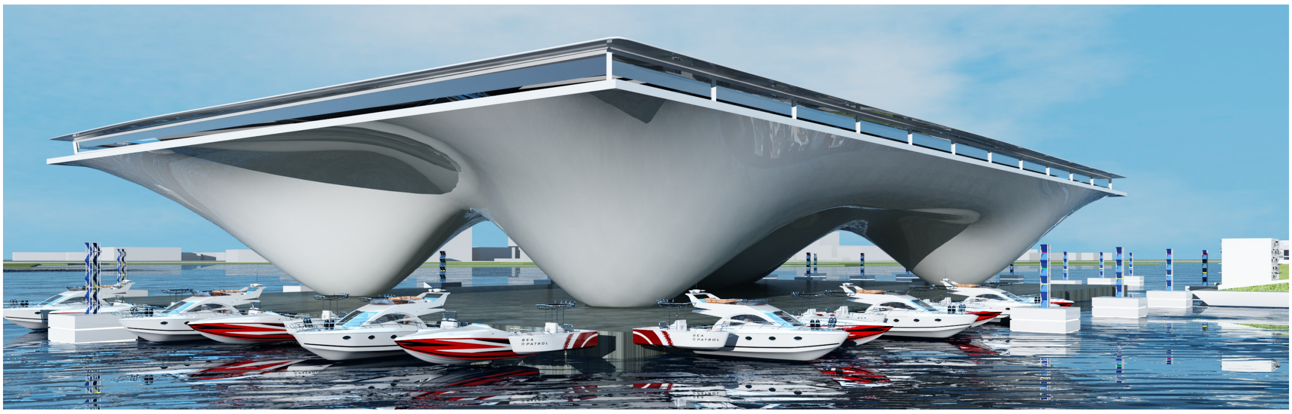


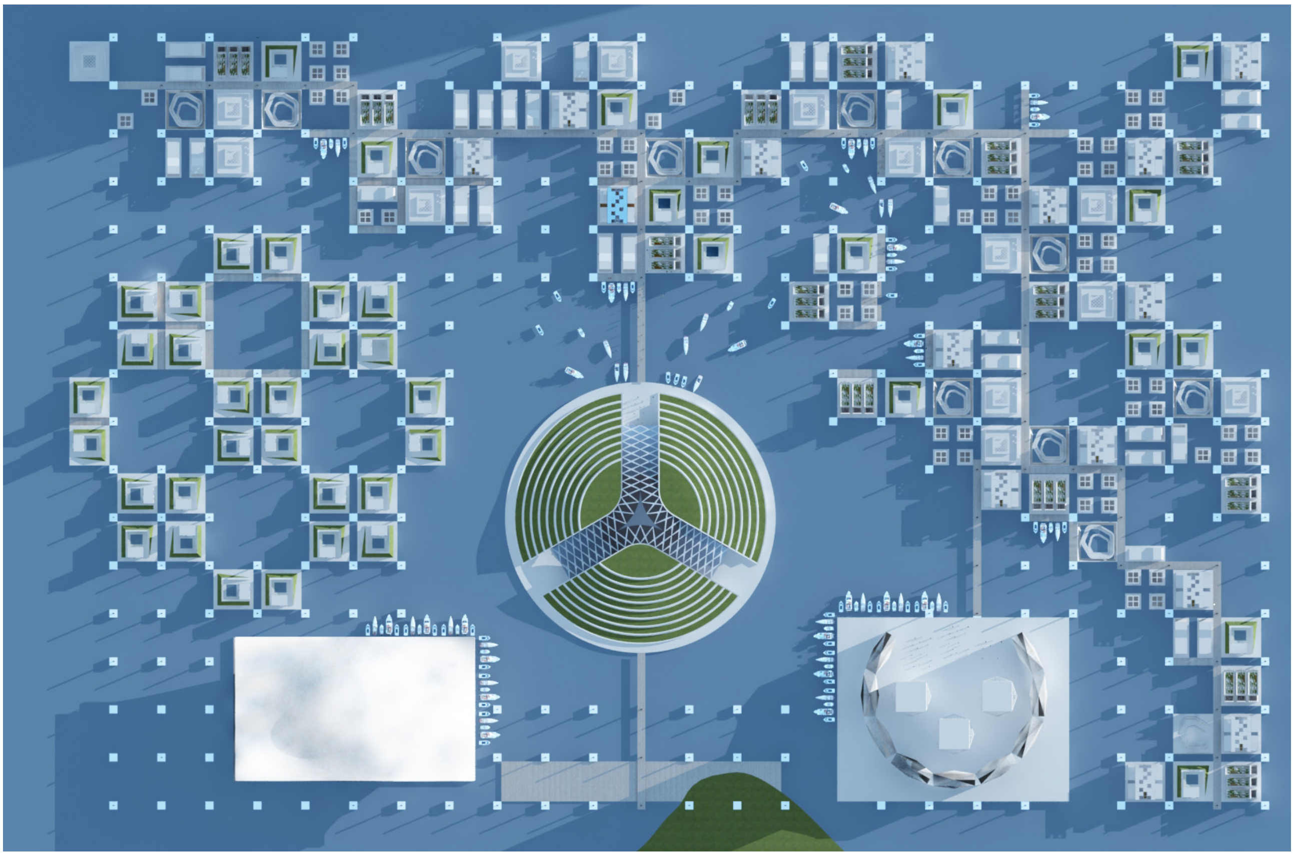


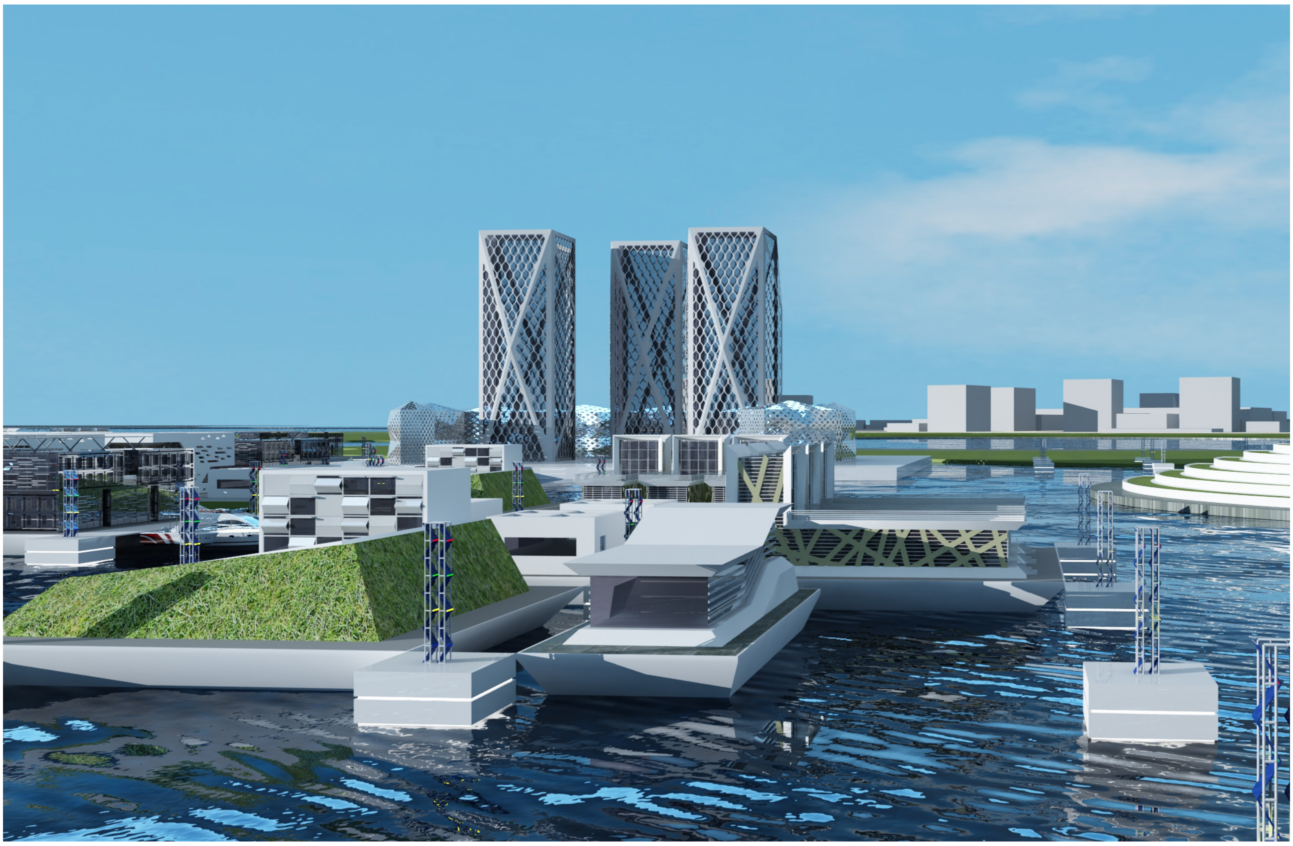



SEA
PATROL

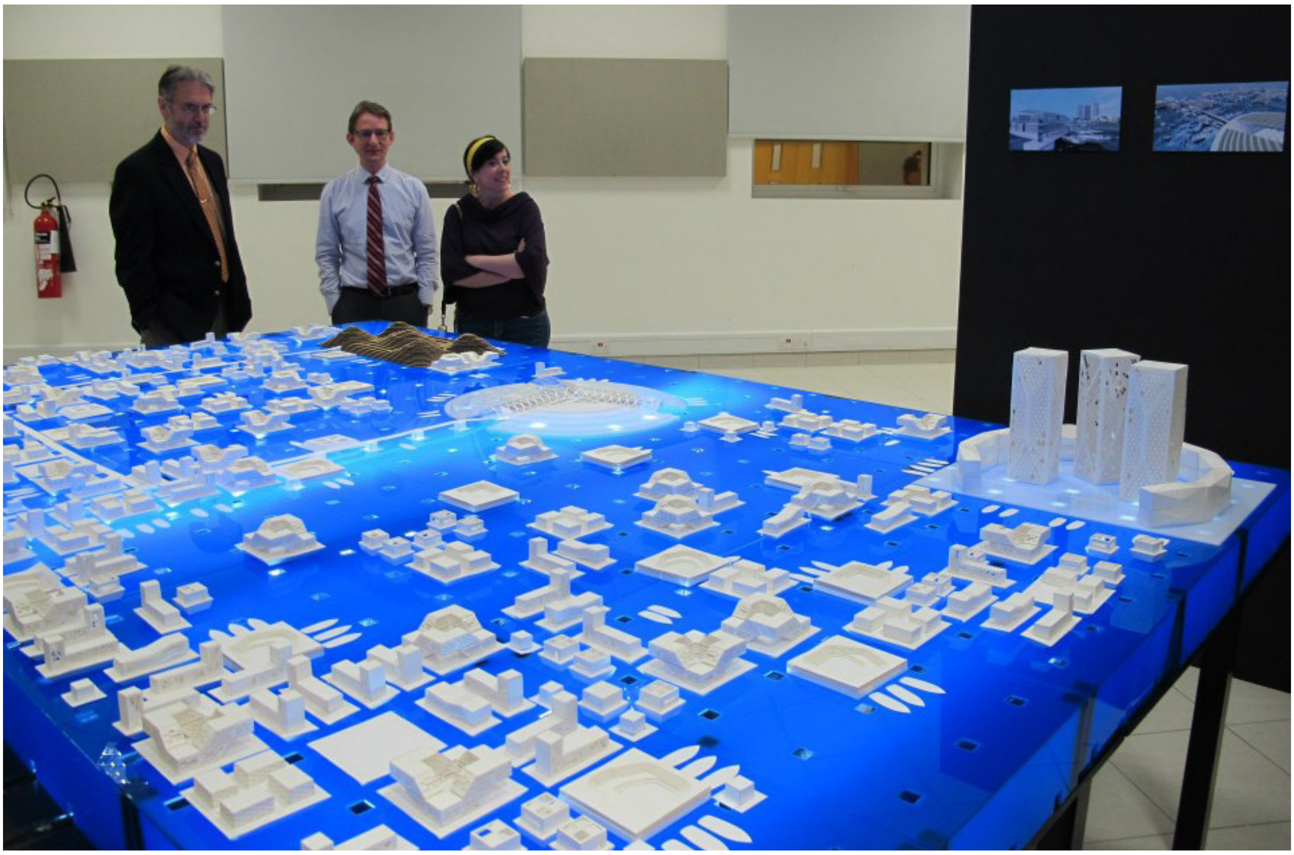


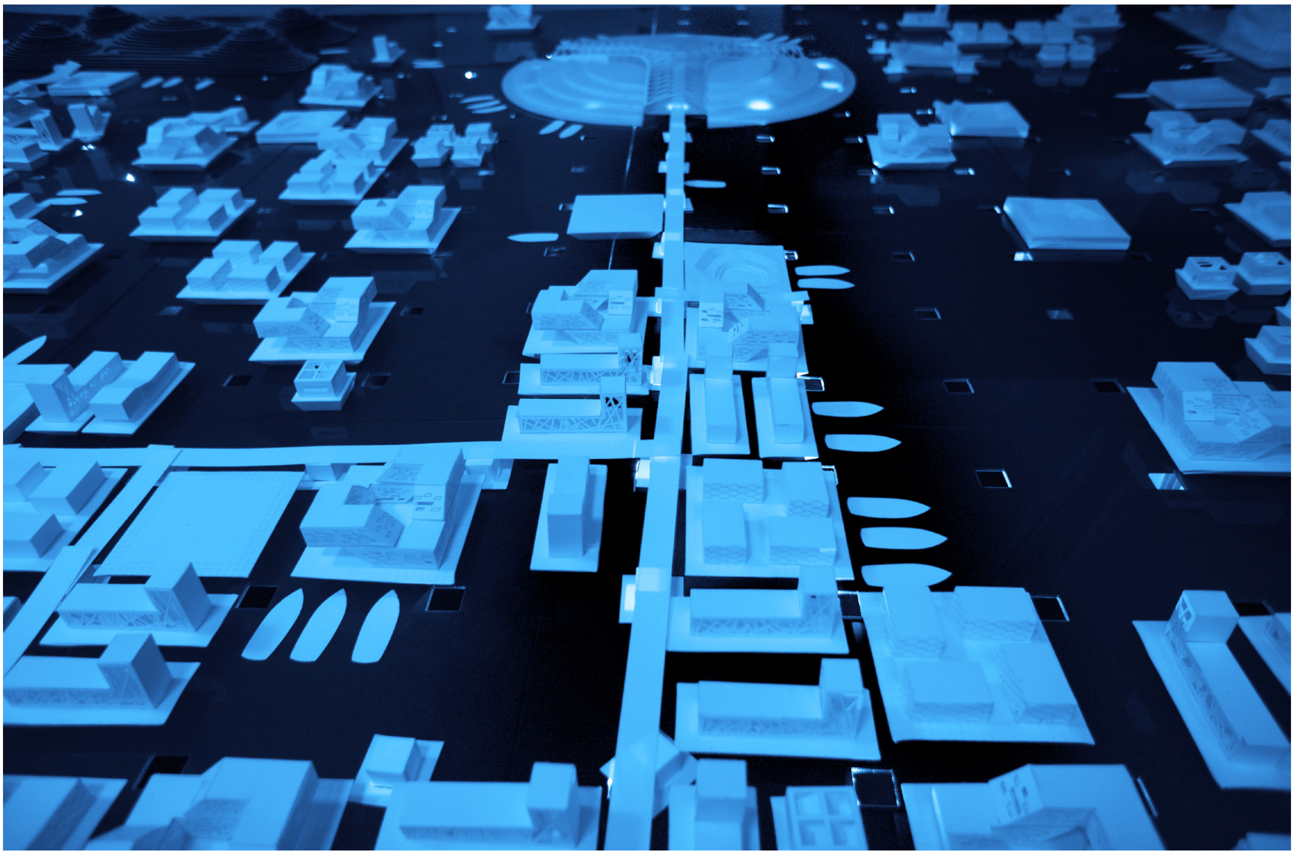


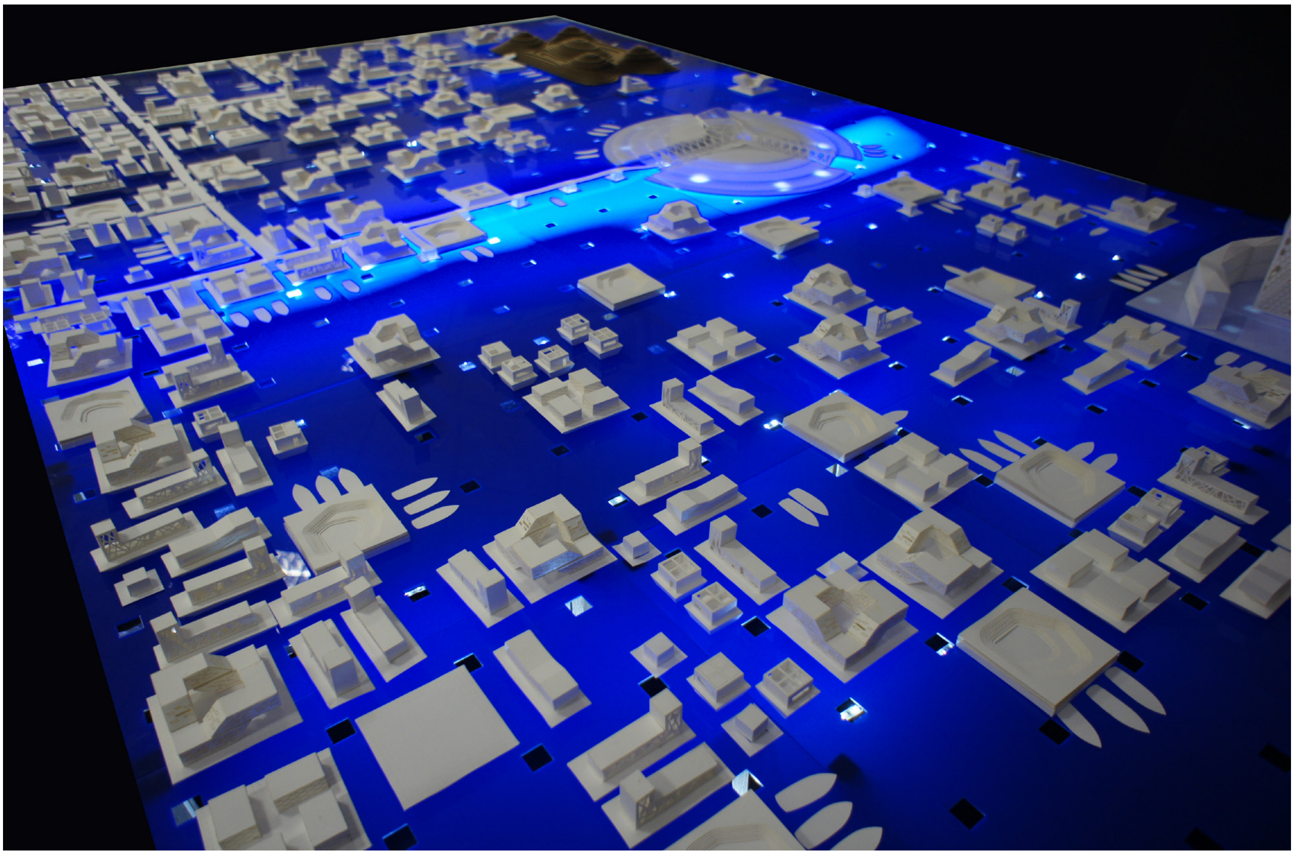




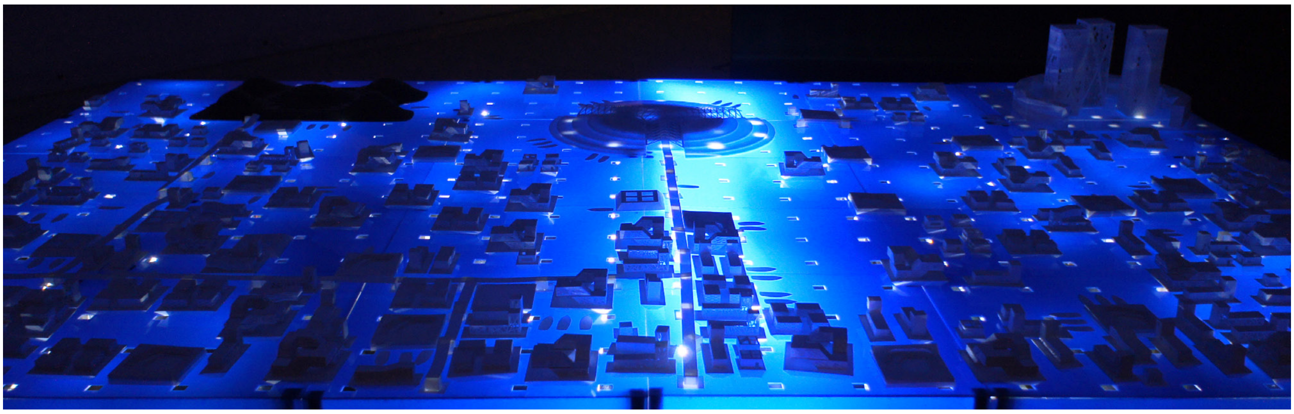
4.18 Exhibition

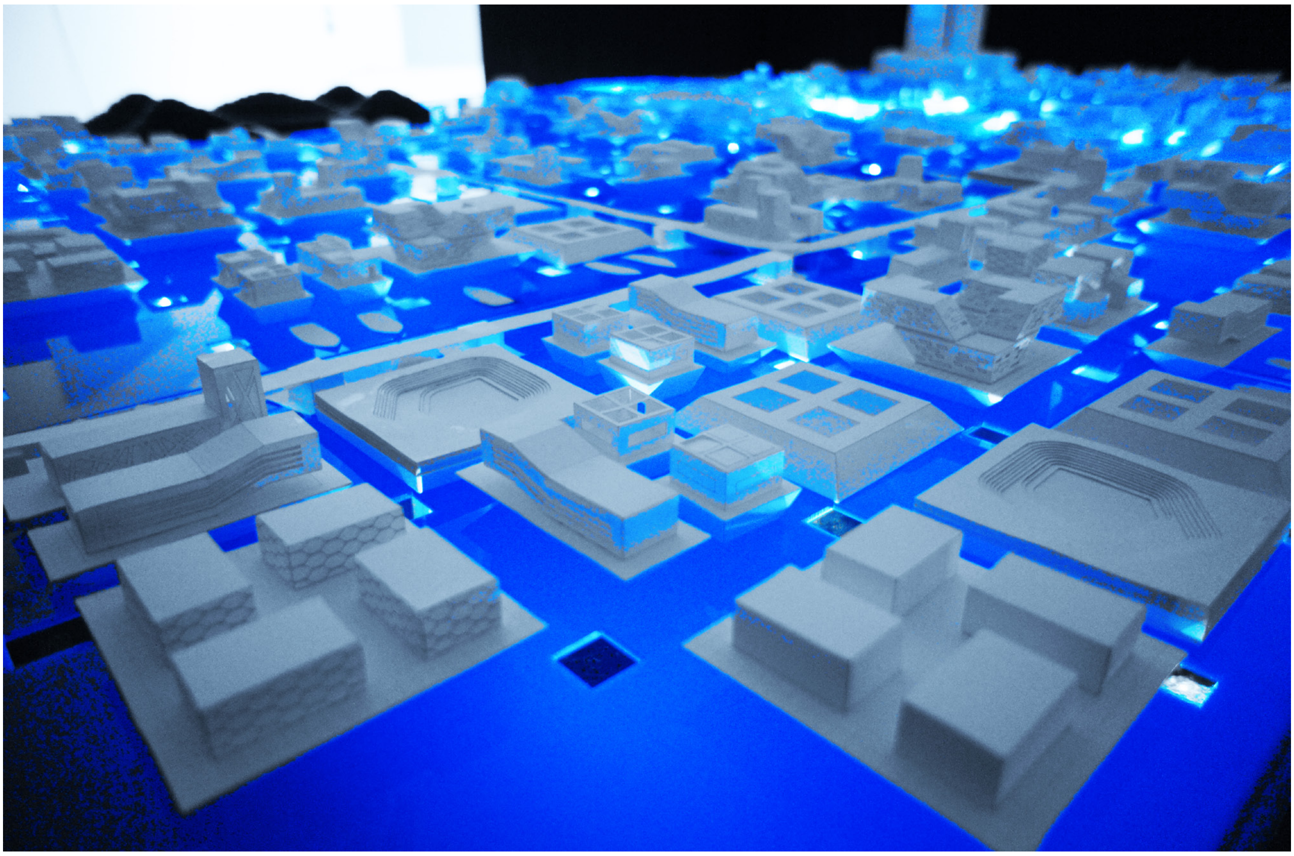


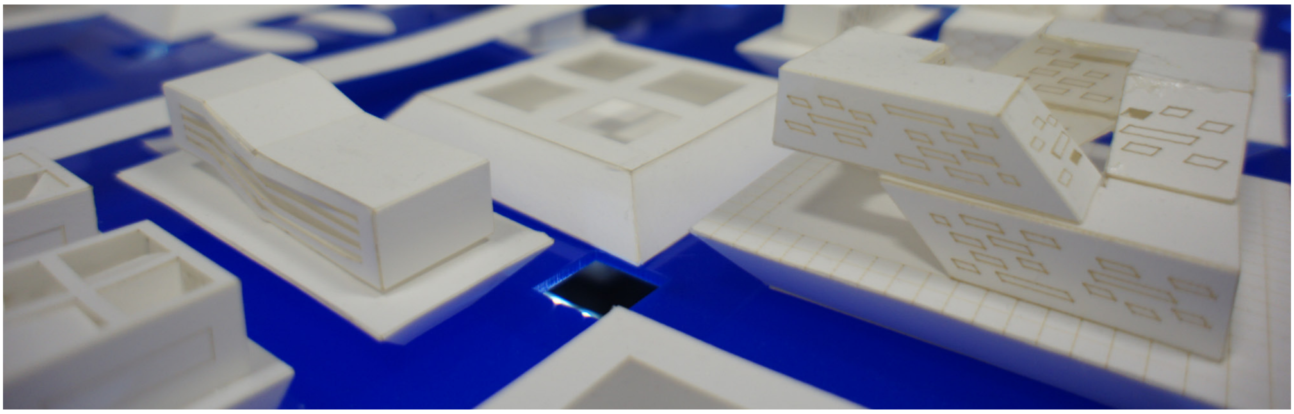


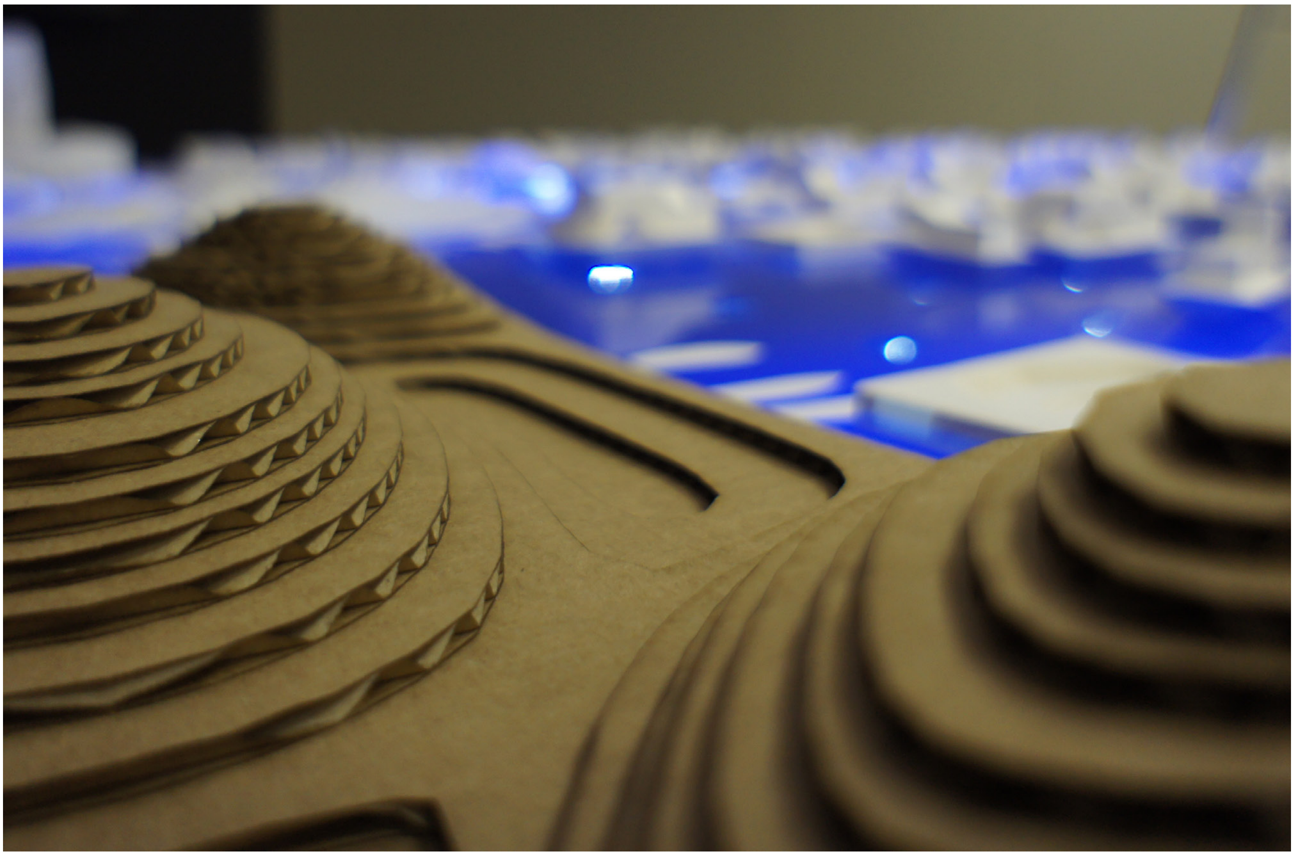


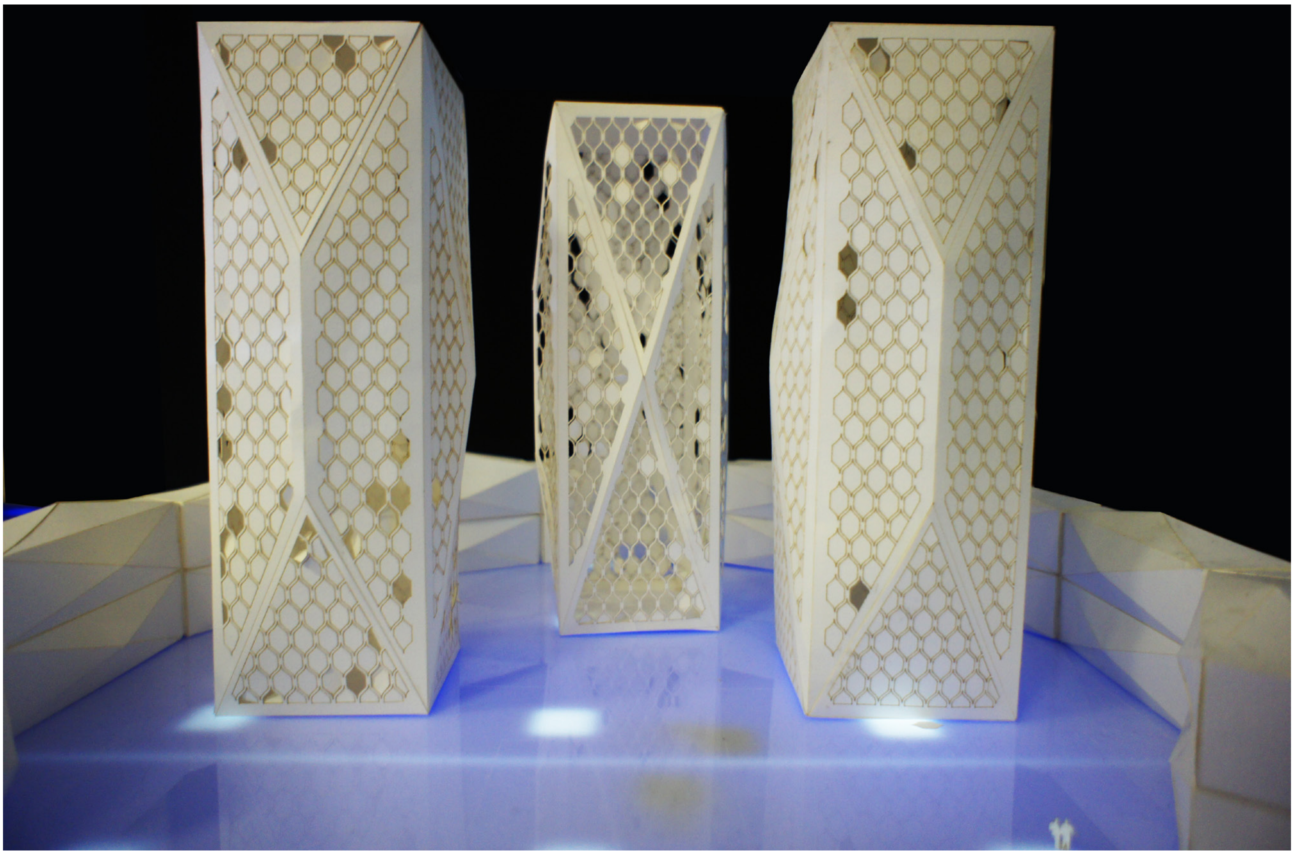
model

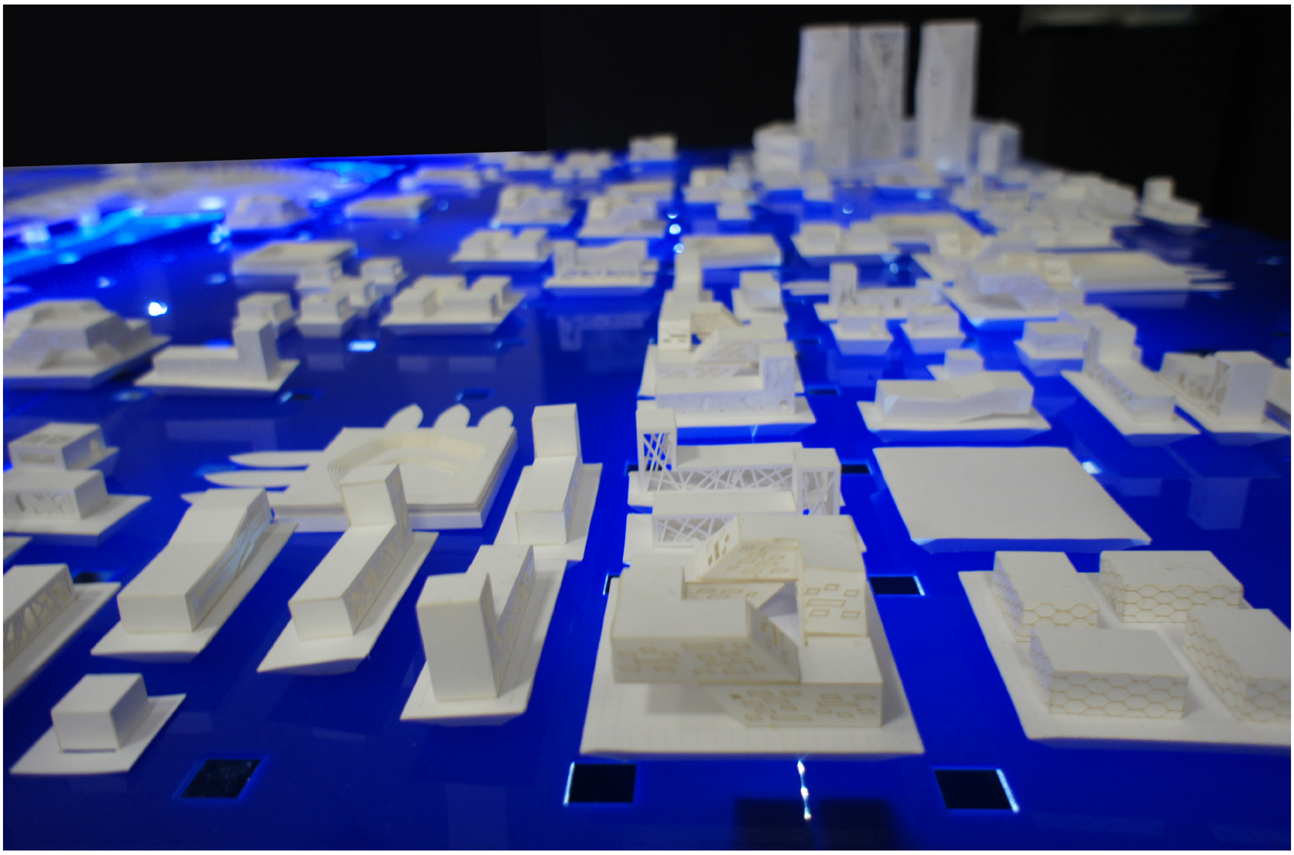


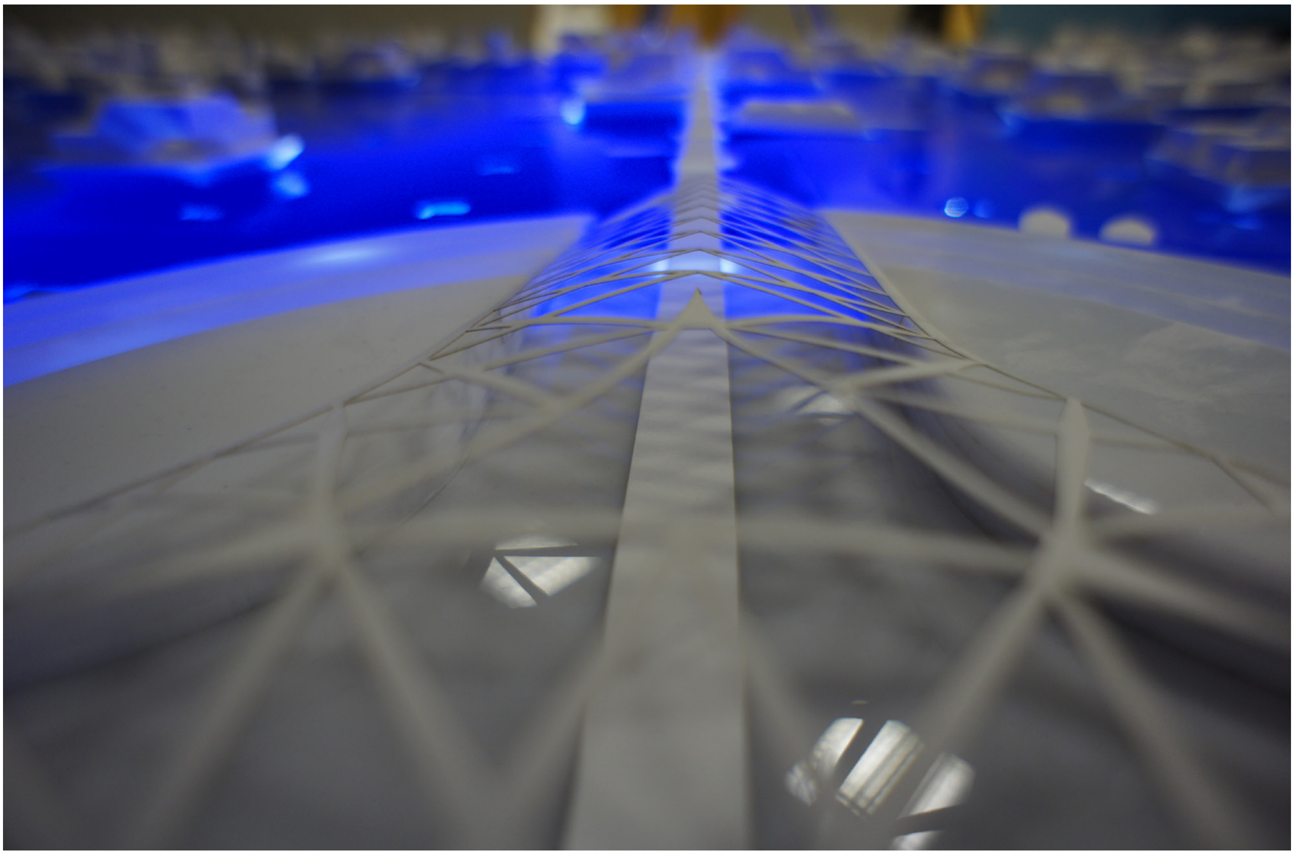












Introduction

This thesis is a motivational thesis, directing us to think in a different way to our urban challenges and toward a new way of living, suggesting solutions to rapid changes and city urban challenges. It suggests an alternative scheme for development on water, intended to be realized with current technologies in the near future. Although the project focuses on Qatar as a case study, the project can be applied to different contexts and cities.

The idea of living on water has existed since a long time ago and has been discussed in many ways and different situations, such as the cases shown in the preceding chapter.

I am suggesting a realistic vision and a step-by-step plan to expand urban fabrics to water—a vision that already exists—but my interpretation , however, is a flexible framework that can be adapted to various changes with different configurations. With the developing technologies, living on water could become a familiar sight in many coastal cities. This in its turn could prepare us to combat future climate challenges and face urban challenges. The notion of living on water is an unlimited and fertile field, but taking the first step is critically important.

Conclusion

Flexibility is sustainability

The concept of a flexible transient community adds a new perspective to sustainability. The lifespan, durability, and ability to be placed in other locations are a sustainable idea in itself.

Sustainability in this project can be explored through the following points:

1. Construction costs.

Although the project does not discuss construction costs in detail, from a general perspective, building floating communities can have a positive impact on reducing the construction costs in countries such as Qatar, in the following ways:

Due to Qatar's small population, the country is importing labors and expatriates (blue and white collar) to help build the country, in addition to importing many construction materials. At the same time, this requires building more housing and facilities to accommodate the imported worker labor and professional labor. Such inflates construction prices, which could be easily reduced in a country with its own labor force.

The transient community provides the ability to manufacture floating units in other locations, including other countries, and can be custom designed in factories to ensure quality controls and then shipped to the site and operated. This means that the cost of the imported materials, labor salaries and housing, and the need to improve the infrastructure, can all be reduced and limited.

This offsite manufacturing can provide better efficiency and quality control while reducing construction waste.

2. Recycling / Reusing.

Floating buildings can be used by diverse inhabitants in various places when no longer needed , and this indeed is sustainability. Transient communities in Qatar can be moved to different coastal cities after the end of events—cities that need it most—and thus serve more need. This means more durability and increased lifespan.

The floating housing unit is a sustainable unit. Compared to a conventional house on land, the foundation of which is considered useless after demolishing the building, the floating foundation can be used in other locations. Moreover, the lightweight housing materials can be replaced by various designs in response to different climates and cultures.

This matches Qatar's plans to dismantle stadiums for the World Cup 2022 and ship them to developing countries [60].

After dismantlement, these buildings can be moved to other countries, leaving no trace and reducing demolition waste.

Living on water is privilege

1. Promoting city visual image.

The idea behind transient communities is to locate people in the heart of coastal cities, especially the city of Doha. Inhabitants could feel the privilege of freedom and openness that exists in the outskirts of the city, and at the same time, remain centered to many important facilities. This would create a unique situation that a city needs to promote its tourism sector. The project acts as an expo of hybrid housing units.

2. Aesthetic value.

Living on water has a great aesthetic value for transient communities as compared to crowded cities, and away from cars and noise. With a direct open view of city skylines from a unique location, the flexibility in this project offers freedom and individuality. Building on water fosters a feeling of liberty and closeness to nature.

3. Investment.

For expatriates, buying floating units could be a future investment. Instead of house renting, inhabitants could invest in buying a housing unit that they could then ship to their country. They could use the unit for housing or for renting. For investors, they could buy units and rent them. During economic slowdowns, they could ship the units and rent them in other locations that need the housing more. This in its turn increases the lifespan of the housing unit.

4. Floating biennale.

The idea of transient communities could promote the role of culture in our live. Art biennales can roam around cities as a part of transient communities.

Delimitations

a. The project is not designed to replace living on land, and it is not designed to be totally independent from land. It suggests a step toward a future vision to explore water. The project focuses on small neighborhoods of limited number of inhabitants. Logistics of larger urban development on water was not discussed in this thesis and not within the scope of the study.

b. The project is not suggesting strict regula- tions but rather general guidelines that can be followed. The dimensions of the project units were assumed based on certain architecture aspects of walkways, living space, and the relation of height and width of the units, not on a scientific study requiring professionals from different fields to help determine the final outcome.

c. The prototypes units are designed for a specific case study of Doha. There is no single typology to offer a universal solution. Urban development must reflect local conditions and cultures. However, the project provides a general flexible framework that can be standardized for different contexts with minor configurations.

Future directions

a. Contacting authorities to realize the project. Realizing the project in Doha is a good communication channel to spread the idea of living on water in the time of the World Cup 2022.

b. The project encourages a larger circle of people to participate: the city authorities, investors and inhabitants can participate at different levels of design in the transient community. Authorities provide locations and facilities to connect the floating community to the main city urban fabric. The investors could provide temporary structures, hotels and other facilities that increase the interaction between the community and the main city. Inhabitants can participate in the design stages of their floating units.

Table of Figures

Figure 40: Toyota prefab steel construction house Prototype, Render. Source: http://freshome.com/2008/07/08/stylish-prefab-homes-units-by-toyota/

Figure 41: Toyota prefab steel construction house Prototype, Render. Source: http://freshome.com/2008/07/08/stylish-prefab-homes-units-by-toyota/

Figure 42: An aerial view of the waterfront community in Lagos
Source: http://www.designboom.com/architecture/nle-architects-floating-school-in-makoko/

Figure 43: An aerial view of Makoko floating school within the context of the waterfront community in Lagos
Source: http://www.designboom.com/architecture/nle-architects-floating-school-in-makoko/

Figure 44: Makoko floating school timber structure.
Source: http://www.designboom.com/architecture/nle-architects-floating-school-in-makoko/

Figure 45: A floating foundation of plastic drums.
Source: http://www.designboom.com/architecture/nle-architects-floating-school-in-makoko/

Figure 46: Boats are used for transportation.
Source: http://www.nleworks.com/case/makoko-floating-school/

Figure 47: A section showing the design of the sustinable floating school
Source: http://www.nleworks.com/case/makoko-floating-school/

Figure 48: A drawing showing the solution derived from integrating the local building technology with global floating technology.
Source: http://www.nleworks.com/case/makoko-floating-school/

Figure 49: Kenzo Tange masterplan for Tokyo 1960
Source: Kenzo Tange official website:
http://www.tangeweb.com/portfolio.php?lang=en#
http://www.tangeweb.com/detail_pdf.php?id=8&lang=en

Figure 50: Layout of Floating city, 2030.
http://bldgblog.blogspot.com/2010/06/flooded-london-2030.html

Figure 51: A collage image of Lilypad islands at Doha waterfront, designed by the author,designed by the author

Figure 52: A render shot of roaming Lilypad floating islands.
Source: http://inhabitat.com/lilypad-floating-cities-in-the-age-of-global-warming/lilypad-floating-cities-biomimicry-inspired-city-lilypad-floating-city-global-warming-solution-rising-seas-concept-refugee-city-climate-refugee/

Figure 53: The Lilypad design was inspired from the waterlily plant.
Source: http://inhabitat.com/lilypad-floating-cities-in-the-age-of-global-warming/lilypad-floating-cities-biomimicry-inspired-city-lilypad-floating-city-global-warming-solution-rising-seas-concept-refugee-city-climate-refugee/

Unless listed below, all photos and illustrations are courtesy of the author

Endnotes.

1. The World Bank, "World Development Indicators: Population Dynamics," The World Bank, last accessed August, 2014, http://wdi.worldbank.org/table/2.1

2. UN-Habitat, State of the World's Cities 2008/9: Harmonious Cities (London: Earthscan, 2008), 15, http://mirror.unhabitat.org/pmss/listItemDetails.aspx?publicationID=2562

3. UN-Habitat, State of the World's Cities 2010/2011: Bridging the Urban Divide. (London: Earthscan, 2010), 15, http://mirror.unhabitat.org/pmss/listItemDetails.aspx?publicationID=2917

4. Unicef, "An Urban World," last accessed October 11, 2014, http://www.unicef.org/sowc2012urbanmap/#

5. United Nations, Department of Economic and Social Affairs, Population Division, World Urbanization Prospects: The 2011 Revision, ESA/P/WP/224, (New York: United Nations, 2012), http://www.un.org/en/development/desa/publications/world-urbanization-prospects-the-2011-revision.html

6. UN-Habitat, Global Report on Human Settlements 2011: Cities and Climate Change (London: Earthscan, 2011), 13, http://unhabitat.org/books/cities-and-climate-change-global-report-on-human-settlements-2011-abridged/

7. R.J. Nicholls, et al., Ranking of the World's Cities Most Exposed to Coastal Flooding Today and in the Future: Executive Summary (Extract from OECD Environment Working Paper No. 1, ENV/WKP(2007)1, 2007), http://www.oecd.org/environment/cc/39729575.pdf.

8. Bruce Stutz, "Too Big to Flood? Megacities Face Futures of Major Storm Risk, Yale Environment 360, December 2012, last accessed November 2014, http://e360.yale.edu/feature/megacities_face_increasing_risk_as_sea_levels_rise/2602/

9. Institution of Civil Engineers, Facing up to the Rising Sea Levels: Retreat? Defend? Attack? The Future of our Coastal and Estuarine Cities (RIBA, year), http://www.buildingfutures.org.uk/assets/downloads/Facing_Up_To_Rising_Sea_Levels.pdf

10. Olthuis, Koen and Keuning, David. "Float!: Building on water to combat urban congestion and climate change". Amsterdam: Frame Publishers, 2010.

11. Richard Florida, Tim Gulden, and Charlotta Mellander, "The Rise of the Mega Region," Cambridge Journal of Regions, Economy and Society, 1(2008): 459–476, doi:10.1093/cjres/rsn018

12. Demographia, Demographia World Urban Areas: 10th Annual Edition (201405 Revision), 20, table 1, http://www.demographia.com/db-worldua.pdf

13. S. M. Skevington, M. Lotfy, and K.A. O'Connell, "The World Health Organization's WHOQOL-BREF Quality of Life Assessment: Psychometric Properties and Results of the International Field Trial, A Report from the WHOQOL Group," Quality of Life Research, 13(2004): 299–310, doi: 10.1023/B:QURE.0000018486.91360.00

14. Robert Kronenburg, Flexible: Architecture that Responds to Change (London: Laurence King Publishing, 2007),

15. Name of author/organization, "Title of Page," last accessed Month day, year, http://www.feedbacq.com Data sources : www.worldbank.org, www.aaro.org, www.ukba.homeoffice.gov.uk, www.migrationinformation.org, www.wikepedia.org

16. Name of author/organization, "Title of Page," last accessed Month day, year, http://www.feedbacq.com Data sources : www.worldbank.org, www.aaro.org, www.ukba.homeoffice.gov.uk, www.migrationinformation.org, www.wikepedia.org

17. U.S Energy information Administration, "Qatar Analysis," last updated January 30, 2014, http://www.eia.gov/countries/cab.cfm?fips=QA&scr=email

18. Lucy Williamson, "Qatar's Fortunes Boom with Gas," BBC News, February 14, 2006, http://news.bbc.co.uk/2/hi/middle_east/4709696.stm

19. FIFA, 2022 FIFA World Cup Bid Evaluation Report: Qatar, (2010), 5, http://www.fifa.com/mm/document/tournament/competition/01/33/74/56/b9qate.pdf

20. World Population Review, "Qatar Population 2014," World Population Review, http://worldpopulationreview.com/countries/qatar-population/

21. Qatar Tourism Authority, 2013 Tourism Statistics Report, https://www.scribd.com/doc/215864599/QTA-Annual-Report-2013.

22. “Tourist Arrivals Up, but Mostly for Business,” The Peninsula, July 30, 2013, http://thepeninsulaqatar.com/news/qatar/247011/tourist-arrivals-up-but-mostly-for-business

23. PWC, Gateway for Growth: Middle East Cities Hotel Forecast for 2014 and 2015, (2014), 19, http://www.PWC.com/me

24. “The Olympic City,” The Olympic City Project, last accessed August day, 2014, http://olympiccityproject.com/

25. Scott Stump and Eun Kyung Kim, “What Happens to Olympic Venues After the Torch Goes Out,” Today, February 22, 2014, http://www.today.com/sochi/what-happens-olympic-venues-after-torch-goes-out-2D12152101

26. Cris Gilbert, “In the Last 20 Years, the Number of Tourists Visiting Barcelona has Tripled,” Ajuntament de Barcelona, November 13, 2013, http://w110.bcn.cat/portal/site/Home/menuitem.14f90aeeb15793636d5d05f320348a0c/?vgnextoid=6099552598552410VgnVCM1000001947900aRCRD&vgnextchannel=0000000000001653VgnV6CONT00000000200RCRD&vgnextfmt=formatDetall&lang=en_GB

27. “Population Pressure,” The Peninsula, October 5, 2013, http://thepeninsulaqatar.com/news/qatar/255757/population-pressure

28. Qatar Ministry of Development, Planning, and Statistics, “Qatar Population 2014,” Ministry of Developing Planning and Statistics-Statistics Sector Website, last accessed August, 2014, http://www.qsa.gov.qa/eng/PopulationStructure.htm

29. Qatar General Secretariat for Development Planning, Qatar National Development Strategy 2011-2016, 55.

30. The World Bank, “Urban Population (% of Total),” The World Bank, last accessed August, 2014, http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS/countries/QA?display=default

31. The World Bank, “Rural Population,” The World Bank, last accessed Month day, year, http://data.worldbank.org/indicator/SP.RUR.TOTL

32. Qatar Ministry of Development, Planning, and Statistics, “Qatar Population 2014,” Ministry of Developing Planning and Statistics-Statistics Sector Website, last accessed August, 2014, http://www.qsa.gov.qa/eng/PopulationStructure.htm

33. HSBC, Expat Explorer Survey 2012, (2012), 8, http://www.expatexplorer.hsbc.com/files/pdfs/overall-reports/2012/report.pdf

34. Ibid., 9.

35. ”100 cars seized daily for wrong overtaking”, Qatar Tribune, July 13, 2014, http://qatar-tribune.com/data/20140713/pdf/index.html#p=1

36. FIFA, 2022 FIFA World Cup Bid, 5.

37. UN-Habitat, Global Report on Human Settlements 2011, 45.

38. “Qatar Seeks to Increase Lifespan of Buildings to 100 Years,” Qatar Tribune, February 1, 2013, http://www.qatar-tribune.com/data/20130201/content.asp?section=Nation1_4

39. Toyota housing, September, 2014. http://www.toyota-global.com/company/profile/non_automotive_business/housing.html

40. The wall street journal, September, 2014. http://online.wsj.com/articles/SB121496449430221935

41. Kunle Adeyemi,” Makoko floating school”, Nleworks, September, 2014. http://www.nleworks.com/case/makoko-floating-school/

42. “As noted by Adeyemi, who also believed that building on water is cheaper than building on land,” architizer.com, September, 2014. http://architizer.com/blog/lagos-floating-school-nle/

43. Japanese Air Danshin Systems, telegraph.com, September, 2014. http://www.telegraph.co.uk/news/worldnews/asia/japan/9122985/Japan-unveils-airbag-earthquake-protection-for-the-home.html

44.”Lagos is one of the world’s fast expanding ‘megacities’. BBC.com. September, 2014. http://news.bbc.co.uk/2/hi/business/8473001.stm

45. “Urban structure for the expanding metropolis: Kenzo Tange’s 1960 plan for Tokyo”, Journal of architectural and planning research 24, 2007, page 109. September, 2014. http://www.nslc.wustl.edu/courses/bio3411/woolsey/Readings/Lecture15/Lin%202007.pdf

46. Anthony Lau, “Flooded London 2030”, Bldblog, September, 2014. http://bldgblog.blogspot.com/2010/06/flooded-london-2030.html

47.” Lau added that the strategy for creating a self-sufficient floating city… can be applied to island nations”, Bldblog, September, 2014. http://bldgblog.blogspot.com/2010/06/flooded-london-2030.html

48. “The floating community is planned to host 50,000 inhabitants”, Inhabitat.com. September, 2014. http://inhabitat.com/lilypad-floating-cities-in-the-age-of-global-warming/

49. Marlis Rohmer,” Waterwoningen”, September, 2014. http://www.rohmer.nl/en/project/waterwoningen-ijburg/

50. “Clasustra”, Natural Energy and Vernacular Architecture: Principles and Examples with Reference to Hot Arid Climates (1986), Section 5, the wind factor in air movement, the clasutrum. Human development library, September, 2014. http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0hdl--00-0----0-10-0---0---0direct-10---4-------0-0l--11-en-50---20-about---00-0-1-00-0-0-11-1-0utfZz-8-10-0-0-11-10-0utfZz-8-00&cl=CL1.12&d=HASHb0d77d7e6d73a01b6e9ec8.6&gt=2

51. “Mashrabiya”, Natural Energy and Vernacular Architecture: Principles and Examples with Reference to Hot Arid Climates (1986), Section 4, the sun factor, openings. Human development library, September, 2014. http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0hdl--00-0----0-10-0---0---0direct-10---4-------0-0l--11-en-50---20-about---00-0-1-00-0-0-11-1-0utfZz-8-10-0-0-11-10-0utfZz-8-00&cl=CL1.12&d=HASHb0d77d7e6d73a01b6e9ec8.6&gt=2

52. “Malgaf”, Natural Energy and Vernacular Architecture: Principles and Examples with Reference to Hot Arid Climates (1986), Section 5, the wind factor in air movement, the malqaf. Human development library, September, 2014. http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0hdl--00-0----0-10-0---0---0direct-10---4-------0-0l--11-en-50---20-about---00-0-1-00-0-0-11-1-0utfZz-8-10-0-0-11-10-0utfZz-8-00&cl=CL1.12&d=HASHb0d77d7e6d73a01b6e9ec8.6&gt=2

53. Guy Debord, “The Society of the Spectacle”, Translated by Donald Nicholson- Smith, University of California press, Ltd, London, England 1999.

54.” National Concrete Canoe Competition”, September, 2014. http://www.asce.org/concrete_canoe/

55. “Seaflex mooring system”, September, 2014. http://www.seaflex.net/

56.”Offshore wind farms by IDEOL”, http://www.ideol-offshore.com/en/floater_overview

57. Olthuis, Koen and Keuning, David. “Float!: Building on water to combat urban congestion and climate change”. Amsterdam: Frame Publishers, 2010.

58. EZdock, September, 2014. http://www.ez-dock.com/

59.”Surego patented an innovative floating bridges that allows 30- degree sideways movement”, September, 2014. http://www.engineeringnews.co.za/article/innovative-bridge-to-improve-safety-in-industry-2013-09-27

60. FIFA. 2022 FIFA World Cup Bid Evaluation Report: Qatar. 2010. Executive summary, page 4. http://www.fifa.com/mm/document/tournament/competition/01/33/74/56/b9qate.pdf

Bibliography

Demographia. Demographia World Urban Areas: 10th Annual Edition (201405 Revision). http://www.demographia.com/db-worldua.pdf

Floridaa, Richard, Tim Guldenb and Charlotta Mellander. “The Rise of the Mega Region.” Cambridge Journal of Regions, Economy and Society, 1(2008): 459–476. doi:10.1093/cjres/rsn018

Gilbert, Cris. “In the Last 20 Years, the Number of Tourists Visiting Barcelona has Tripled.” Ajuntament de Barcelona, November 13, 2013. http://w110.bcn.cat/portal/site/Home/menuitem.14f90aeeb15793636d5d05f320348a0c/?vgnextoid=6099552598552410VgnVCM1000001947900aRCRD&vgnextchannel=0000000000001653VgnV6CONT00000000200RCRD&vgnextfmt=formatDetall&lang=en_GB

HSBC. Expat Explorer Survey 2012. 2012. http://www.expatexplorer.hsbc.com/files/pdfs/overall-reports/2012/report.pdf

Hughes, Jonathan, and Sadler, Simon. “NON-PLAN, Essays on freedom participation and change in modern architecture and urbanism”. Oxford: Architectural Press, 2000. Essay 10, 116-126.

Institution of Civil Engineers. Facing up to the Rising Sea Levels: Retreat? Defend? Attack? The Future of our Coastal and Estuarine Cities. RIBA, 2010. http://www.buildingfutures.org.uk/assets/downloads/Facing_Up_To_Rising_Sea_Levels.pdf

FIFA. 2022 FIFA World Cup Bid Evaluation Report: Qatar. 2010. http://www.fifa.com/mm/document/tournament/competition/01/33/74/56/b9qate.pdf

Florida, Richard, Tim Gulden, and Charlotta Mellander, “The Rise of the Mega Region,” Cambridge Journal of Regions, Economy and Society, 1(2008): 459–476, doi:10.1093/cjres/rsn018

Klein, Richard J. T., Robert J. Frank and Frank Thomalla. “The Resilience of Coastal Megacities to Weather-Related Hazards.” Building Safer Cities. Washington, DC: The World Bank, 2003. http://www.preventionweb.net/files/638_8681.pdf.

Klein, Richard J. T., Robert J. Nicholls, and Frank Thomalla. “Resilience to Natural Hazards: How Useful is This Concept?” Environmental Hazards, 5 (2003): 35-45. doi:10.1016/j.hazards.2004.02.001

Kronenburg, Robert. Flexible: Architecture that Responds to Change. London: Laurence King Publishing, 2007.

Lynch, Kevin. “The image of the city”. Cambridge: The MIT Press, 2002.

Nicholls, R. J., S. Hanson, C. Herweijer, N. Patmore, S. Hallegatte, Jan Corfee-Morlot, Jean Chateau, and Muir-Wood. Ranking of the World’s Cities Most Exposed to Coastal Flooding Today and in the Future: Executive Summary. Extract from OECD Environment Working Paper No. 1, ENV/WKP(2007)1. 2007. http://www.oecd.org/environment/cc/39729575.pdf.

Olthuis, Koen and Keuning, David. “Float!: Building on water to combat urban congestion and climate change” Amsterdam: Frame Publishers, 2010.

“Population Pressure.” The Peninsula, October 5, 2013. http://thepeninsulaqatar.com/news/qatar/255757/population-pressure.

PWC. Gateway for Growth: Middle East Cities Hotel Forecast for 2014 and 2015. 2014. http://www.PWC.com/me

Schwartz-Clauss, Mathias. “Living in Motion: Design and architecture for flexible dwelling”. Weil am Rhein, Vitra Design Stifung gGmbh and contributors , 2002.

Skevington, S. M., M. Lotfy, and K.A. O’Connell. “The World Health Organization’s WHOQOL-BREF Quality of Life Assessment: Psychometric Properties and Results of the International Field Trial, A Report from the WHOQOL Group.” Quality of Life Research, 13(2004): 299–310. doi: 10.1023/B:QURE.0000018486.91360.00

Spiller, Neil. “Visionary Architecture”. London: Thames and Hudson Ltd, 2006.

Stump, Scott and Eun Kyung Kim. “What Happens to Olympic Venues After the Torch Goes Out.” February 22, 2014. http://www.today.com/sochi/what-happens-olympic-venues-after-torch-goes-out-2D12152101

Stutz, Bruce. “Too Big to Flood? Megacities Face Futures of Major Storm Risk. Yale Environment 360. December 2012. Last accessed November 2014. http://e360.yale.edu/feature/megacities_face_increasing_risk_as_sea_levels_rise/2602/

Tagaris, Karolina. “Ten Years On, Athens 2004 Gives Greece Little to Cheer.” Ekathimerini.com, August 7, 2014. http://www.ekathimerini.com/4dcgi/_w_articles_wsite5_1_07/08/2014_541997

“The Olympic City.” The Olympic City Project. Last accessed August, 2014. http://olympiccityproject.com/

The World Bank. “Urban Population (% of Total).” The World Bank. Last accessed August, 2014. http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS/countries/QA?display=default

——. “Rural Population.” The World Bank. Last accessed August, 2014, http://data.worldbank.org/indicator/SP.RUR.TOTL

——. “World Development Indicators: Population Dynamics.” The World Bank. Last accessed August, 2014, 2014. http://wdi.worldbank.org/table/2.1

“Tourist Arrivals Up, but Mostly for Business.” The Peninsula, July 30, 2013. http://thepeninsulaqatar.com/news/qatar/247011/tourist-arrivals-up-but-mostly-for-business

UN-Habitat. Global Report on Human Settlements 2011: Cities and Climate Change. London: Earthscan, 2011. http://unhabitat.org/books/cities-and-climate-change-global-report-on-human-settlements-2011-abridged/

——. State of the World’s Cities Report 2008/9: Harmonious Cities. London: Earthscan, 2008. http://mirror.unhabitat.org/pmss/listItemDetails.aspx?publicationID=2562

——. State of the World’s Cities 2010/2011: Bridging the Urban Divide. London: Earthscan, 2010. http://mirror.unhabitat.org/pmss/listItemDetails.aspx?publicationID=2917

Unicef. “An Urban World.” Last accessed October 11, 2014. http://www.unicef.org/sowc2012/urbanmap/#

United Nations. Department of Economic and Social Affairs. Population Division. World Urbanization Prospects: The 2011 Revision, ESA/P/WP/224. New York: United Nations, 2012. http://www.un.org/en/development/desa/publications/world-urbanization-prospects-the-2011-revision.html

U.S. Energy information Administration. "Qatar Analysis." Last updated January 30, 2014. http://www.eia.gov/countries/cab.cfm?fips=QA&scr=email

Williamson, Lucy. "Qatar's Fortunes Boom with Gas." BBC News, February 14, 2006. http://news.bbc.co.uk/2/hi/middle_east/4709696.stm

World Population Review. "Qatar Population 2014." World Population Review. http://worldpopulationreview.com/countries/qatar-population/

Qatar General Secretariat for Development Planning. Qatar National Development Strategy 2011-2016. Doha: Gulf Publishing and Printing, 2011. http://www.gsdp.gov.qa/gsdp_vision/docs/NDS_EN.pdf.

Qatar Ministry of Development, Planning, and Statistics. "Qatar Population 2014." Ministry of Developing Planning and Statistics-Statistics Sector Website. Last accessed August, 2014. http://www.qsa.gov.qa/eng/PopulationStructure.htm

"Qatar Seeks to Increase Lifespan of Buildings to 100 Years." Qatar Tribune, February 1, 2013. http://www.qatar-tribune.com/data/20130201/content.asp?section=Nation1_4

Qatar Tourism Authority. 2013 Tourism Statistics Report. https://www.scribd.com/doc/215864599/QTA-Annual-Report-2013.